

Appendix A

ENP PROTECTION AND EXPANSION ACT

PUBLIC LAW 101-229

Everglades National Park Protection and Expansion Act of 1989 [Enrolled Bill (Sent to President)]

***One Hundred First Congress of the United States of America
AT THE FIRST SESSION***

Begun and held at the City of Washington on Tuesday, the third day of January, one thousand nine hundred and eighty-nine

An Act

To modify the boundaries of the Everglades National Park and to provide for the protection of lands, waters, and natural resources within the park, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the 'Everglades National Park Protection and Expansion Act of 1989'.

TITLE I--EVERGLADES NATIONAL PARK EXPANSION

SEC. 101. FINDINGS, PURPOSES AND DEFINITION OF TERMS.

(a) FINDINGS- The Congress makes the following findings:

- (1) The Everglades National Park is a nationally and internationally significant resource and the park has been adversely affected and continues to be adversely affected by external factors which have altered the ecosystem including the natural hydrologic conditions within the park.
- (2) The existing boundary of Everglades National Park excludes the contiguous lands and waters of the Northeast Shark River Slough that are vital to long-term protection of the park and restoration of natural hydrologic conditions within the park.
- (3) Wildlife resources and their associated habitats have been adversely impacted by the alteration of natural hydrologic conditions within the park, which has contributed to an overall decline in fishery resources and a 90 percent population loss of wading birds.
- (4) Incorporation of the Northeast Shark River Slough and the East Everglades within the park will limit further losses suffered by the park due to habitat destruction outside the present park boundaries and will preserve valuable ecological resources for use and enjoyment by future generations.
- (5) The State of Florida and certain of its political subdivisions or agencies have indicated a willingness to transfer approximately 35,000 acres of lands under their jurisdiction to the park in order to protect lands and water within the park, and may so transfer additional lands in the future.

- (6) The State of Florida has proposed a joint Federal-State effort to protect Everglades National Park through the acquisition of additional lands.
- (b) PURPOSE- The purposes of this Act are to--
- (1) increase the level of protection of the outstanding natural values of Everglades National Park and to enhance and restore the ecological values, natural hydrologic conditions, and public enjoyment of such area by adding the area commonly known as the Northeast Shark River Slough and the East Everglades to Everglades National Park; and
 - (2) assure that the park is managed in order to maintain the natural abundance, diversity, and ecological integrity of native plants and animals, as well as the behavior of native animals, as a part of their ecosystem.
- (c) DEFINITIONS- As used in this Act:
- (1) The term 'Secretary' means the Secretary of the Interior.
 - (2) The term 'addition' means the approximately 107,600 acre area of the East Everglades area authorized to be added to Everglades National Park by this Act.
 - (3) The term 'park' means the area encompassing the existing boundary of Everglades National Park and the addition area described in paragraph (2).
 - (4) The term 'project' means the Central and Southern Florida Project.

SEC. 102. BOUNDARY MODIFICATION.

- (a) AREA INCLUDED- The park boundary is hereby modified to include approximately 107,600 acres as generally depicted on the map entitled 'Boundary Map, Everglades National Park Addition, Dade County, Florida', numbered 160-20,013B and dated September 1989. The map shall be on file and available for public inspection in the offices of the National Park Service, Department of the Interior.
- (b) BOUNDARY ADJUSTMENT- The Secretary may from time to time make minor revisions in the boundaries of the park in accordance with section 7(c) of the Land and Water Conservation Fund Act of 1965 (16 U.S.C. 4601-4 and following). In exercising the boundary adjustment authority the Secretary shall ensure all actions will enhance resource preservation and shall not result in a net loss of acreage from the park.
- (c) ACQUISITION- (1) Within the boundaries of the addition described in subsection (a), the Secretary may acquire lands and interests in land by donation, purchase with donated or appropriated funds, or exchange. For purposes of acquiring property by exchange, the Secretary may, notwithstanding any other provision of law, exchange the approximately one acre of Federal land known as 'Gilberts' Marina' for non-Federal land of equal value located within the boundaries of the addition. Any lands or interests in land which are owned by the State of Florida or any political subdivision thereof, may be acquired only by donation.
- (2) It is the express intent of Congress that acquisition within the boundaries of the addition shall be completed not later than 5 years after the date of enactment of this section. The authority provided by this section shall remain in effect until all acquisition is completed.
- (d) ACQUISITION OF TRACTS PARTIALLY OUTSIDE BOUNDARIES- When any tract of land is only partly within boundaries referred to in subsection (a), the Secretary may acquire all or any portion of the land outside of such boundaries in order to minimize the payment of severance costs. Land so acquired outside of the boundaries may be exchanged by the Secretary for non-Federal lands within the boundaries, and any land so acquired and not utilized for exchange shall be reported to the General Services Administration for disposal under the Federal Property and Administrative Services Act of 1949 (63 Stat. 377).

(e) OFFERS TO SELL- In exercising the authority to acquire property under this Act, the Secretary shall give prompt and careful consideration to any offer made by any person owning property within the boundaries of the addition to sell such property, if such owner notifies the Secretary that the continued ownership of such property is causing, or would result in undue hardship.

(f) AUTHORIZATION OF APPROPRIATIONS- (1) Subject to the provisions of paragraph (2), there are hereby authorized to be appropriated such sums as may be necessary to carry out the provisions of this Act.

(2) With respect to land acquisition within the addition, not more than 80 percent of the cost of such acquisition may be provided by the Federal Government. Not less than 20 percent of such cost shall be provided by the State of Florida.

(g) ASSISTANCE- Upon the request of the Governor of the State of Florida, the Secretary is authorized to provide technical assistance and personnel to assist in the acquisition of lands and waters within the Kissimmee River/Lake Okeechobee/Everglades Hydrologic Basin, including the Big Cypress Swamp, through the provision of Federal land acquisition personnel, practices, and procedures. The State of Florida shall reimburse the Secretary for such assistance in such amounts and at such time as agreed upon by the Secretary and the State. Notwithstanding any other provision of law, reimbursement received by the Secretary for such assistance shall be retained by the Secretary and shall be available without further appropriation for purposes of carrying out any authorized activity of the Secretary within the boundaries of the park.

SEC. 103. ADMINISTRATION.

(a) IN GENERAL- The Secretary shall administer the areas within the addition in accordance with this Act and other provisions of law applicable to the Everglades National Park, and with the provisions of law generally applicable to units of the national park system, including the Act entitled 'An Act to establish a National Park Service, and for other purposes', approved August 25, 1916 (39 Stat. 535; 16 U.S.C. 1-4). In order to further preserve and protect Everglades National Park, the Secretary shall utilize such other statutory authority as may be available to him for the preservation of wildlife and natural resources as he deems necessary to carry out the purposes of this Act.

(b) PROTECTION OF ECOSYSTEM- The Secretary shall manage the park in order to maintain the natural abundance, diversity, and ecological integrity of native plants and animals, as well as the behavior of native animals, as a part of their ecosystem.

(c) PROTECTION OF FLORA AND FAUNA- The park shall be closed to the operation of airboats--

(1) except as provided in subsection (d); and

(2) except that within a limited capacity and on designated routes within the addition, owners of record of registered airboats in use within the addition as of January 1, 1989, shall be issued nontransferable, nonrenewable permits, for their individual lifetimes, to operate personally-owned airboats for noncommercial use in accordance with rules prescribed by the Secretary to determine ownership and registration, establish uses, permit conditions, and penalties, and to protect the biological resources of the area.

(d) CONCESSION CONTRACTS- The Secretary is authorized to negotiate and enter into concession contracts with the owners of commercial airboat and tour facilities in existence on or before January 1, 1989, located within the addition for the provision of such services at their current locations under such rules and conditions as he may deem

necessary for the accommodation of visitors and protection of biological resources of the area.

(e) VISITOR CENTER- The Secretary is authorized and directed to expedite the construction of the visitor center facility at Everglades City, Florida, as described in the Development Concept Plan, Gulf Coast, dated February 1989, and upon construction shall designate the visitor center facility as 'The Marjory Stoneman Douglas Center' in commemoration of the vision and leadership shown by Mrs. Douglas in the protection of the Everglades and Everglades National Park.

SEC. 104. MODIFICATION OF CERTAIN WATER PROJECTS.

(a) IMPROVED WATER DELIVERIES- (1) Upon completion of a final report by the Chief of the Army Corps of Engineers, the Secretary of the Army, in consultation with the Secretary, is authorized and directed to construct modifications to the Central and Southern Florida Project to improve water deliveries into the park and shall, to the extent practicable, take steps to restore the natural hydrological conditions within the park.

(2) Such modifications shall be based upon the findings of the Secretary's experimental program authorized in section 1302 of the 1984 Supplemental Appropriations Act (97 Stat. 1292) and generally as set forth in a General Design Memorandum to be prepared by the Jacksonville District entitled 'Modified Water Deliveries to Everglades National Park'. The Draft of such Memorandum and the Final Memorandum, as prepared by the Jacksonville District, shall be submitted as promptly as practicable to the Committee on Energy and Natural Resources and the Committee on Environment and Public Works of the United States Senate and the Committee on Interior and Insular Affairs and the Committee on Public Works and Transportation of the United States House of Representatives.

(3) Construction of project modifications authorized in this subsection and flood protection systems authorized in subsections (c) and (d) are justified by the environmental benefits to be derived by the Everglades ecosystem in general and by the park in particular and shall not require further economic justification.

(4) Nothing in this section shall be construed to limit the operation of project facilities to achieve their design objectives, as set forth in the Congressional authorization and any modifications thereof.

(b) DETERMINATION OF ADVERSE EFFECT- (1) Upon completion of the Final Memorandum referred to in subsection (a), the Secretary of the Army, in consultation with the South Florida Water Management District, shall make a determination as to whether the residential area within the East Everglades known as the 'Eight and One-Half Square Mile Area' or adjacent agricultural areas, all as generally depicted on the map referred to in subsection 102(a), will be adversely affected by project modifications authorized in subsection (a).

(2) In determining whether adjacent agricultural areas will be adversely affected, the Secretary of the Army shall consider the impact of any flood protection system proposed to be implemented pursuant to subsection (c) on such agricultural areas.

(c) FLOOD PROTECTION; EIGHT AND ONE-HALF SQUARE MILE AREA- If the Secretary of the Army makes a determination pursuant to subsection (b) that the 'Eight and One-Half Square Mile Area' will be adversely affected, the Secretary of the Army is authorized and directed to construct a flood protection system for that portion of presently developed land within such area.

(d) FLOOD PROTECTION; ADJACENT AGRICULTURAL AREA- (1) If the Secretary of the Army determines pursuant to subsection (b) that an adjacent agricultural area will be adversely affected, the Secretary of the Army is authorized and directed to construct a

flood protection system for such area. Such determination shall be based on a finding by the Secretary of the Army that:

- (A) the adverse effect will be attributable solely to a project modification authorized in subsection (a) or to a flood protection system implemented pursuant to subsection (c), or both; and
- (B) such modification or flood protection system will result in a substantial reduction in the economic utility of such area based on its present agricultural use.

(2) No project modification authorized in subsection (a) which the Secretary of the Army determines will cause an adverse effect pursuant to subsection (b) shall be made operational until the Secretary of the Army has implemented measures to prevent such adverse effect on the adjacent agricultural area: *Provided*, That the Secretary of the Army or the South Florida Water Management District may operate the modification to the extent that the Secretary of the Army determines that such operation will not adversely affect the adjacent agricultural area: *Provided further*, That any preventive measure shall be implemented in a manner that presents the least prospect of harm to the natural resources of the park.

(3) Any flood protection system implemented by the Secretary of the Army pursuant to this subsection shall be required only to provide for flood protection for present agricultural uses within such adjacent agricultural area.

(4) The acquisition of land authorized in section 102 shall not be considered a project modification.

(e) PERIODIC REVIEW- (1) Not later than 18 months after the completion of the project modifications authorized in subsection (a), and periodically thereafter, the Secretary of the Army shall review the determination of adverse effect for adjacent agricultural areas.

(2) In conducting such review, the Secretary of the Army shall consult with all affected parties, including, but not limited to, the Secretary, the South Florida Water Management District and agricultural users within adjacent agricultural areas.

(3) If, on the basis of such review, the Secretary of the Army determines that an adjacent agricultural area has been, or will be adversely affected, the Secretary of the Army is authorized and directed, in accordance with the provisions of subsection (d), to construct a flood protection system for such area: *Provided*, That the provisions of subsection (d)(2) shall be applicable only to the extent that the Secretary, in consultation with the Secretary of the Army, determines that the park will not be adversely affected.

(4) The provisions of this subsection shall only be applicable if the Secretary of the Army has previously made a determination that such adjacent agricultural area will not be adversely affected.

(f) CURRENT CANAL OPERATING LEVELS- Nothing in this section shall be construed to require or prohibit the Secretary of the Army or the South Florida Water Management District from maintaining the water level within any project canal below the maximum authorized operating level as of the date of enactment of this Act.

(g) NO LIMITATION ON OTHER CLAIMS- If the Secretary of the Army makes a determination of no adverse effect pursuant to subsection (b), such determination shall not be considered as a limitation or prohibition against any available legal remedy which may otherwise be available.

(h) COORDINATION- The Secretary and the Secretary of the Army shall coordinate the construction program authorized under this section and the land acquisition program authorized in section 102 in such a manner as will permit both to proceed concurrently and as will avoid unreasonable interference with property interests prior to the acquisition of such interests by the Secretary under section 102.

(i) WEST DADE WELLFIELD- No Federal license, permit, approval, right-of-way or assistance shall be granted or issued with respect to the West Dade Wellfield (to be located in the Bird Drive Drainage Basin, as identified in the Comprehensive Development Master Plan for Dade County, Florida) until the Secretary, the Governor of the State of Florida, the South Florida Water Management District and Dade County, Florida enter into an agreement providing that the South Florida Water Management District's water use permit for the wellfield, if granted, must include the following limiting conditions: (1) the wellfield's peak pumpage rate shall not exceed 140,000,000 gallons per day; (2) the permit shall include reasonable, enforceable measures to limit demand on the wellfield in times of water shortage; and (3) if, during times of water shortage, the District fails to limit demand on the wellfield pursuant to (2), or if the District limits demand on the wellfield pursuant to (2), but the Secretary certifies that operation of the wellfield is still causing significant adverse impacts on the resources of the Park, the Governor shall require the South Florida Water Management District to take necessary actions to alleviate the adverse impact, including, but not limited to, temporary reductions in the pumpage from the wellfield.

(j) PROTECTION OF NATURAL VALUES- The Secretary of the Army is directed in analysis, design and engineering associated with the development of a general design memorandum for works and operations in the 'C-111 basin' area of the East Everglades, to take all measures which are feasible and consistent with the purposes of the project to protect natural values associated with Everglades National Park. Upon completion of a general design memorandum for the area, the Secretary shall prepare and transmit a report to the Committee on Energy and Natural Resources and the Committee on Environment and Public Works of the United States Senate and the Committee on Interior and Insular Affairs and the Committee on Public Works and Transportation of the United States House of Representatives on the status of the natural resources of the C-111 basin and functionally related lands.

Appendix B

COMPLIANCE WITH ENVIRONMENTAL LAWS, REGULATIONS, AND EXECUTIVE ORDERS

CENTRAL AND SOUTHERN FLORIDA STUDY
GENERAL REEVALUATION REPORT and
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT
(RGRR/SEIS) for TAMIAMI TRAIL MODIFICATIONS

MODIFIED WATER DELIVERIES TO
EVERGLADES NATIONAL PARK, FLORIDA

Compliance of Each Alternative with Relevant Federal Laws,
Regulations, and Executive Orders

Anadromous Fish Conservation Act

As defined in the Anadromous Fish Conservation Act, 16 U.S.C. 757a-g, 79 Stat. 1125, as amended by PL 89-304, anadromous fish species would not be affected.

Archeological Resources Protection Act of 1979

This project complies with the provisions of the Archeological Resources Act of 1979, as amended, 16 USC 470 *et seq.*, P.L. 96-95, relative to archeological resources on public lands.

Barrier Resources Act and Coastal Barrier Improvement Act of 1990

There are no designated coastal barrier resources in the project area that would be affected by this project. The project is in compliance.

Clean Air Act of 1972

At this stage of planning, this project complies with Section 309 of the Clean Air Act of 1972, as amended, 42 U.S.C. 1857h-7, *et seq.* PL 91-604.

Clean Water Act of 1972

The project complies with the Clean Water Act, as amended, (Federal Water Pollution Control Act) 33 U.S.C. 1251, *et seq.* PL 92-500. A copy of the 404(b)(1) Evaluation is included in Appendix I. In accordance with the laws of the State of Florida, Florida Department of Environmental Protection (FDEP) will not issue a Water Quality Certification (WQC) until advanced plans and specifications for construction are submitted. Once these detailed drawings are developed during the preconstruction engineering and design phase, USACE will seek a modification to the existing WQC for the Modified Water Deliveries (MWD) project.

Coastal Zone Management Act of 1972

This project is consistent with the Florida Coastal Zone Management Program (see Appendix G) and complies with the Coastal Zone Management Act of 1972, as amended, 16 U.S.C. 1451, *et seq.* PL 92-583.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1996

The Hazardous, Toxic, and Radioactive Waste (HTRW) assessment performed as part of this project complies with the requirements of CERCLA and SARA.

Endangered Species Act of 1973

This project complies with the Endangered Species Act of 1973, as amended, 16 U.S.C. 1531, *et seq.*; PL 93-205. The U.S. Army Corps of Engineers (USACE) has made a commitment to providing ornithological observers during construction, and to stage construction, such that it does not interrupt nesting activities at the two wood stork rookeries located in close proximity to Tamiami Trail. Coordination between Federal and state wildlife officials will continue throughout the planning stage of the project. A Biological Assessment is included as Appendix F.

Estuary Protection Act of 1968

No designated estuary would be affected by project activities. The Estuary Protection Act of 1968, 16 U.S.C. 1221, *et seq.* PL 90-454 is not applicable.

Farmland Protection Policy Act of 1981

No prime or unique farmland would be impacted by implementation of this project. Lands to each side of the highway are publicly owned marshlands. The project is in compliance.

Federal Water Project Recreation Act

This project is in full compliance with the Federal Water Project Recreation Act, as amended, 16 U.S.C 460-1 (12), *et seq.*, P.L. 89-72.

Fish and Wildlife Coordination Act of 1958

This project is currently being coordinated with the U.S. Fish and Wildlife Service (USFWS). A Coordination Act Report (CAR) has been received and is included as Appendix F.

Fishery Conservation and Management Act of 1976

An Essential Fish Habitat assessment is not required for this project. No adverse effect on fisheries would result from the proposed action. This project complies fully with the Magnuson-Stevens Fishery Conservation Act, as amended in 1996, 16 U.S.C. 1801, *et seq.* PL 04-265.

Lands Act of 1953

This project is in compliance with the State Sovereignty and Submerged Lands program and the Submerged Lands Act of 1953, 43 U.S.C. 1301, *et seq.*

Marine Mammal Protection Act of 1972

No marine mammals would be affected by this project. Provisions of the Marine Mammal Protection Act of 1968, as amended, 16 U.S.C. 1361, *et seq.* PL 92-522, do not apply.

Marine Protection, Research, and Sanctuaries Act

The Marine Protection, Research and Sanctuaries Act, 33 U.S.C. 1401, *et seq.* PL 92-532 (33 U.S.C. 1402)(f)) does not apply to this project.

Migratory Bird Treaty Act and Migratory Bird Conservation Act

No migratory birds would be affected by project activities. The project is in compliance with the Migratory Bird Conservation Act, 16 U.S.C. 715-715d, 715e, 715f-715r; 45 Stat. 1222 and the Migratory Bird Treaties and other international agreements listed in the Endangered Species Act of 1973, as amended, Section 2(a)(4).

National Environmental Policy Act of 1969

The project complies with the National Environmental Policy Act of 1969, as amended, 42 U.S.C. 4321, *et seq.* PL 91-190.

National Historic Preservation Act of 1966 (Inter Alia)

Consultation with the Florida State Historic Preservation Officer (SHPO) has been initiated in accordance with the National Historic Preservation Act, as amended, 16 U.S.C. 470a, *et seq.*; PL 89-655; the Archeological and Historic Preservation Act, as amended, and Executive Order (EO) 11593.

Native American Graves Protection and Repatriation Act of 1990

The project complies with the provisions of the Native American Graves Protection and Repatriation Act, as amended, 25 U.S.C. 3008, *et seq.*, P.L. 101-601.

Resource Conservation and Recovery Act (RCRA) as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984

The Hazardous, Toxic, and Radioactive Waste (HTRW) assessment performed as part of this project complies with the requirements of RCRA and HSWA..

River and Harbor and Flood Control Act of 1970

The River and Harbor and Flood Control Act of 1970 (P.L. 91-611) places certain requirements on the Corps of Engineers for evaluating public works projects. This project complies with those requirements.

Rivers and Harbors Act of 1899

This project would not obstruct navigable waters of the United States. The action has been subject to the public notice, public hearing, and other evaluations normally conducted for activities subject to the Rivers and Harbors Act of 1899, as amended, 33 U.S.C. 401, *et seq.* The project is in full compliance.

Water Project Recreation Act

This project is in full compliance with the Federal Water Project Recreation Act, as amended, 16 U.S.C. 460-1 (12), *et seq.* PL 89-72.

Wild and Scenic River Act of 1968

No designated Wild and Scenic river reaches would be affected by project related activities.

Executive Order 11514, Protection of Environment.

E.O. 11514, Protection and Enhancement of Environmental Quality, directs federal agencies to *"initiate measures needed to direct their policies, plans and programs so as to meet national environmental goals."* This project complies with E.O. 11514.

Executive Order 11988, Flood Plain Management

This E.O. instructs Federal Agencies to avoid development in flood plains to the maximum extent feasible. The current project is not a "development" but rather a floodplain restoration action. This project is being developed in compliance with E.O. 12898.

Executive Order 11990, Protection of Wetlands

The wetlands of ENP would be enhanced by this project. This project complies with the goals of this executive order.

Executive Order 12898, Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, provides that each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority or low-income populations. Efforts were made to avoid, minimize, or compensate for any adverse effect of this project on the Native Americans living in the project area. This project complies fully with the requirements of this executive order.

Executive Order 12962, Recreational Fisheries

Executive Order 12962 requires the evaluation of federally funded, permitted, or authorized actions on aquatic systems and recreational fisheries. This project complies with E.O. 12962.

Executive Order 13045, Protection of Children

Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, requires each Federal agency to "identify and assess environmental risks and safety risks [that] may disproportionately affect children" and ensure that its "policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks." This project complies with the requirements of E.O. 13045.

Executive Order 13112, Invasive Species

Executive Order 13112, *Invasive Species*, establishes the National Invasive Species Council to “prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause.” This project complies with the intent of E.O. 13112.

Appendix C

CULTURAL RESOURCES

**Executive Summary of the Cultural Resource Survey of the
Tamiami Trail, Modified Waters to the Everglades National Park –
GRR/SEIS, Miami-Dade County, Florida**

Contract No. W912EP-04-D-0030

Report submitted to:

U.S. Army Corps of Engineers, Jacksonville District • 701 San
Marco Blvd.
Jacksonville, Florida 32207-8175

Report prepared by:

New South Associates • 6150 East Ponce de Leon Avenue • Stone
Mountain, Georgia 30083

J.W. Joseph, PhD, RPA –
Principal Investigator

Jennifer Azzarello – Archaeologist-Ethnographer and Co-Author and
Jennifer Langdale – Historian and Co-Author

New South Associates Technical Report 1284

July 22, 2005

Introduction

The US Army Corps of Engineers, Jacksonville District proposes to construct a bridge on Highway 41 (Tamiami Trail). The purpose of constructing this bridge is to increase water flow between portions of the Everglades lying north and south of Highway 41. The US Army Corps of Engineers, Jacksonville District has initiated this work as part of the Modified Waters to the Everglades National Park - GRR/SEIS.

From June 1 to June 30, New South Associates (NSA) conducted Cultural Resource Survey of the Tamiami Trail, Modified Waters to the Everglades National Park - GRR/SEIS, Miami-Dade County, Florida. New South Associates, Inc. was contracted to conduct the following work: (1) identify and assess the National Register of Historic Places (NRHP) eligibility of the historic properties located within the project area, (2) complete archaeological survey of areas with the potential for archaeological sites, (3) conduct archival research on the history and cultural use of this region, and (4) conduct interviews in order to assess each historic resource and its potential as a Traditional Cultural Property as defined by the National Register Bulletin #38, *Guidelines for Evaluating and Documenting Traditional Cultural Properties*. New South Associates conducted this work in compliance with the National Historic Preservation Act of 1966 (PL 89-665), as amended, and the Archaeological and Historic Preservation Act of 1974 (PL 93-291).

NSA, Inc. has: (1) conducted archival research on the historical and cultural use of the region, (2) completed the Phase I Archaeological survey and Architectural Survey to identify and assess NRHP eligibility of the historic properties, and (3) conducted ethnographic interviews with individuals knowledgeable of the traditional use of the area and the Tamiami Canal to attempt to identify if the canal is a Traditional Cultural Property.

The project area lies within northwest Dade County County, Florida on the Tamiami Trail and Tamiami Canal. The project area extends from eastern landmark at Pump Station S-334 to Pump Station S-333 on Tamiami Canal, Dade County, Florida. The north-south boundaries are 30.5 m north of the berm and 30.5 m south of the southern edge of Highway 41. Nearly two-thirds of the western and southern parts of the county are within the Florida Everglades and the Everglades National Park.

Background Research

Prior to conducting fieldwork, NSA conducted background research at the Florida Master Site File (FMSF), the Florida Collection of the Florida State Library in Tallahassee, and the National Register of Historic Places. Additional research was undertaken at the University of Florida libraries, the Miami-Dade Public Library, and the Historical Museum of Southern Florida. Sources consulted include newspapers, historic maps, clipping files, periodicals, and secondary works.

New South conducted research at the FMSF and located eight sites within, and just outside, of the project area (Florida Master Site File [FMSF], 8DA2225, 8DA2226, 8DA3242, 8DA3243, 8DA6765, 8DA6766, 8DA6767, and 8DA6768, Archaeological Site Form, Tallahassee). Four prehistoric archaeological sites (8DA2225, 8DA2226, 8DA3242, and 8DA3243) are located outside of the project area. Four historic sites, previously recorded by Janus Research (2001), are located within the project area. These historic resources are: Tamiami Trail (8DA6765), Tamiami Canal (8DA6766), Coopertown Airboat Rides and Restaurant (8DA6767), and Airboat Association of Florida (8A6768) (Janus Research 2001). Three properties were recommended potentially eligible to be listed to the National Register of Historic Places (NRHP) Tamiami Trail, Tamiami Canal, and Coopertown Airboat Rides and Restaurant.

Field Methodology

As part of this investigation, New South Associates conducted three tasks: (1) archival research, literature review, and interview knowledgeable individuals to refine the history of known and potential resources in the survey area, (2) a Phase I Archaeological Survey and an Architectural Survey to document the historic properties previously identified (Janus Research 2001) and any newly discovered properties with photographs, maps, sketch plans, and site inventory forms, and (3) interviews with individuals who are knowledgeable about the cultural usage and association of the region.

Archaeological Field Methods

The archaeological survey required the visual examination and limited shovel testing along the area that is the right-of-way (ROW) of Hwy 41 lying between S-334 Pump Station, the eastern boundary landmark, and S-34, the western boundary landmark. The northern APE boundary extended 30.5 m to the north of the berm along the Tamiami Canal and 30.5 m to the south of the southern edge of Hwy 41. The archaeological survey was conducted to

determine if cultural resources were present along any portion of the 11-mile corridor.

Shovel testing was conducted at 30-meter (99-ft) intervals in the selected areas of archeological potential. All tests were a minimum of 40 centimeters in diameter and dug to a depth of one meter, unless impeded by water or lime-rock. Many of the shovel tests were dug in the very poorly drained areas consisting of muck, peat, or marl over limestone. All soils were screened through 0.64 centimeters (0.25 inch) hardware cloth for standardized data recovery. All shovel test data were recorded in field logbooks and their locations plotted on the USGS Topographic 7.5' Cooperstown and Long Island Quadrangle Maps.

Ethnographic Interview Methods

New South Associates conducted its ethnographic investigations of the project area from June 1 through June 9, 2005. Two types of interviews were conducted, informal and formal interviews where 33 informants participated. New South developed an interview schedule that was used for both types of interviews.

The informal interviews were primarily conducted with the fishermen and women along the Tamiami Canal. New South's ethnographer, Jennifer Azzarello, approached these individuals as they were fishing along the canal. The formal interviews were conducted by contacting informants prior to the interview where a location, date, and time was arranged. Each of the four informants for the formal interviews agreed to conduct a taped interview, were made aware of the scope of the project, and were given release forms to sign.

Architectural History Methods

NSA's architectural historian resurveyed the historic properties within the project area in order to assess them for NRHP eligibility. The 2001 report submitted by Janus Research recommended that three properties (Coopertown Airboat Rides and Restaurant, Tamiami Trail, and Tamiami Canal) were potentially eligible to the NRHP. The FL SHPO concurred with their recommendations. These three properties were reviewed only for changes that may have occurred since 2001. Other structures along the Trail that were either not surveyed or recommended as not eligible to the NRHP by Janus Research in 2001, were reassessed for their NRHP eligibility.

Results of the Archaeological Survey

New South Associates began its investigations on June 1, 2005. A Phase I Archaeological survey of the project area was conducted in all areas where testing was thought possible. There were very few places to test within the project area and of those places there were little to no areas to excavate a shovel test. New South's field crew was able to locate six areas within the project area (Areas A - F) where shovel testing was thought to be possible. In addition to Areas A - F, Sites 8DA2226, 8DA6765, and 8DA6766 were also evaluated for their shovel testing potential within the project area.

Area A was located in front of a Miccosukee Indian village at the west end of the project area where three negative shovel tests were excavated. Area B was located within the Everglades Safari Park. Most of the areas located within Area B were covered in pavement for the park's parking lot, however, there was one area located across their airboat channel where one negative test was excavated. Area C was the Airboat Association of Florida; NSA did not excavate any shovel tests at this location, as most of project area was parking lot. Area D was an area on the map identified as Frog City. Two negative shovel tests were excavated at this location. Area E was Gator Park; NSA was unable to excavate any shovel tests in this location, as most of project area was parking lot. Area F was Coopertown Restaurant and Airboat Rides; NSA was unable to excavate any shovel tests in this location, as most of project area was parking lot.

The previously recorded sites that appeared to have little potential for shovel testing and were located just outside of the project area were, Sites 8DA2226, 8DA6765, and 8DA6766. Site 8DA2226 is a previously recorded archaeological site that sits 150 m north of the northern boundary of the project area. New South did not identify any cultural material along the northern berm and noted that the area directly north of the berm is wet. Sites 8DA6765 (Tamiami Trail) and 8DA6766 (Tamiami Canal) are previously recorded archaeological sites that lie in the center of the project area and found to be considered potentially eligible for listing in the NRHP under Criterion A in the areas of Transportation and Engineering. The FL SHPO concurred with their recommendation. New South did not place any shovel tests within these site locations due to the modern construction impediments but does recognize these two sites as large-scale archaeological features in the area. No archaeological deposits were located at any of the areas (Areas A - F) or at the previously recorded sites within the project area.

Results of the Ethnographic Interviews

NSA conducted ethnographic interviews with local fishermen fishing along the Tamiami Canal, local business owners, and the members of the Airboat Association of Florida. A total of 33 people were approached during this investigation. Three types of interviews took place: informal, formal (taped), formal (not taped). All of the interviews were conducted by Jennifer Azzarello and on occasion with Joshua Dunn (NSA Archaeological Field Technician). Based on the results of the Ethnographic investigations, the cultural heritage and practices that take place along the Tamiami Trail and Canal are not limited to just this location but occur throughout the Everglades. None of these practices on the Tamiami Canal appear to define the identity of the groups involved and the Canal and Tamiami Trail do not appear to qualify as TCPs. However, the Everglades as a whole does contribute to the identity of many of those interviewed for this project, as well as others, most notably the Seminole, and the tones and tenor in which people spoke about the Everglades echoed those used when discussing TCPs. It would also appear that the Everglades factor into the current identity and beliefs of the Seminole, and the Jacksonville District may want to consider a broader ethnographic study of the Everglades to assess its meaning and determine if it might qualify as a TCP.

Overview of Interviews Along the Canal

Many fishermen and women came specifically to the Tamiami Canal to fish for both recreation and food. Many individuals came for the recreation of fishing in a natural environment and if they had a good day and caught good-eating fish they took them home to eat. Most fishermen and women said they fish all of the canals, but they come the Tamiami Canal because it is good fishing and it is a more natural environment. It is also clear that many of the fishermen and women come from low-income households; the canal system in South Florida has provided a form of inexpensive recreation that they can come and enjoy alone or as a family. The South Florida canal systems, as part of the Everglades, clearly are areas that several different culture groups utilized to conduct their traditional cultural practices.

Overview of Interviews with the Airboat Association of Florida

New South Associates contacted the Airboat Association of Florida prior to conducting investigations in Dade County, Florida. The Airboat Association's representative, Joell Marco responded with generosity and enthusiasm to do what he could to share with the Ethnographer about their cultural heritage of the Everglades. As the Airboat Association's representative, Joell took Azzarello

out on his airboat allowing her to take part in the longtime tradition of frogging, or frog-gigging. Additionally, he set up a barbeque at the Airboat Association's club house where Azzarello was able to formally interview three older gentlemen who had lived in the area, air-boating almost all of their lives.

All of the members of the Airboat Association of Florida were proud to be part of the organization and expressed their concern that their air-boating heritage was in danger of being lost if the bridge was to be built. All of the members felt there was a significant amount of cultural heritage that could be found in many cultures that created ties to not only the canal but to the Everglades as a whole. From the interviews and conversations with members of the Airboat Association of Florida, there is clearly a cultural heritage that can be traced even to the original settlement of the Everglades. Activities such as air-boating, frogging, and other hunting activities have been part of cultural uses of the Everglades. Today these activities take place in an evolved form adhering to the regulations and laws that are now part of the management of the Everglades.

Recommendations of the Ethnographic Interviews

New South Associates has determined that the cultural heritage and practices documented for the Tamiami Canal do not qualify it as a TCP. Ethnographic interviews did identify a strong association between representatives of a range of cultural groups and the Everglades itself. Further ethnographic research on the history, usage and meaning of the Everglades is recommended to determine if the Everglades as a whole warrant consideration as a TCP.

Results of the Architectural Field Survey

Five historic buildings and structures were surveyed as a result of this project; each are described below.

8DA10088 - Gator Park, 24050 SW 8th Street

The architectural field survey identified one new historic property, Gator Park (8DA10088). The ten-acre property consists of a c. 1950 concrete block structure as well as another non-historic outbuilding, a campground, wildlife show area, and airboat docking facilities. The building was probably constructed as a gas station. Its large porte cochere suggests such a usage. Employees at Gator Park also remember it serving as a bar. It became an airboat concession around 1989 (Kelly 1986; Miami-Dade County Tax Assessor).

Recommendation: Although Gator Park is an active airboat concession and tourist destination along the Tamiami Trail, this is not its historic purpose. The building has also been altered from its original appearance with the addition of the shingle siding on the main façade. Because the building is lacking in integrity and does not have a long history as a tourist attraction, New South Associates recommends that this property is not eligible to the NRHP.

8DA6765 - Tamiami Trail

Janus Research surveyed the Tamiami Trail in 2001. New South Associates reevaluated the site for alterations and saw no changes since the initial survey. Janus Research recommended the Trail potentially eligible to the NRHP. The FL SHPO concurred with their recommendation.

Recommendation: New South Associates recommends that the Tamiami Trail is eligible to the NRHP under Criteria A and C. The Janus report provides an excellent overview of the construction and history of the Tamiami Trail. This road, which took thirteen years to build, was a true feat in engineering as the process and conditions were unprecedented in highway construction. Contemporary reports note that there was not a hard surface road from Miami to Fort Myers in 1915. "The project from Fort Myers to Miami was not only conquering the Everglades and Big Cypress but blazing a trail through what was before 1915 an almost unexplored section of Florida" (Tamiami Trail Commissioners 1928: 3). It provided a route across the peninsula and an opportunity for thousands of citizens to see the Everglades from their automobiles and not a canal boat. The Tamiami brought a new age for the Seminoles living in the Everglades and provided an avenue for them and their white contemporaries to venture into the tourist trade that continues to flourish in south Florida.

8DA6766 - Tamiami Canal

Janus Research surveyed the Tamiami Canal in 2001. New South Associates reevaluated the site for alterations and saw no changes since the initial survey. Janus Research recommended that the Trail potentially eligible to the NRHP. The FL SHPO concurred with their recommendation.

Recommendation: The Tamiami Canal would not exist without the Tamiami Trail. It is impossible to separate the historical and engineering significance of the two structures. New South Associates recommends that the Tamiami Canal is eligible to the NRHP under Criteria A and C.

8DA6767 - Coopertown, 22702 SW 8th Street

Janus Research surveyed Coopertown in 2001. New South Associates reevaluated the site for alterations and saw no changes since the initial survey. Janus Research recommended Coopertown as potentially eligible to the NRHP. The FL SHPO concurred that the property is eligible to the NRHP. New South Associates agrees that Coopertown should be considered eligible to the NRHP.

8DA6768 - Airboat Association of Florida, 25400 Tamiami Trail

The fourth property Janus identified was the Airboat Association of Florida (8DA6768). Janus recommended that the property is ineligible to the NRHP. The FL SHPO concurred with this recommendation. Since this recommendation was made, local citizens have voiced concerns and some believe that the property has historical value. As a result of this interest, the Army Corps of Engineers requested that New South Associates pay careful attention to the AAF property. Unfortunately, the Airboat Association of Florida Board of Directors denied the architectural historian access to the property and a full re-evaluation could not be undertaken at this time. However, a preliminary recommendation can be made based on the Janus survey with the assumption that the historic structure on the property remains relatively unchanged since 2001.

Recommendation: By reviewing the survey forms and information submitted by Janus and combining it with the fieldwork and research recently undertaken by New South Associates, we recommend that the Airboat Association of Florida property is potentially eligible to the NRHP under Criterion A.

The Airboat Association of Florida is the principal proponent for the sport of airboating in this section of the Everglades. The members of the group strive to preserve their sense of outdoorsmanship and their access to frog hunting grounds and airboating trails with zeal. Their environmental work is also notable and deserves further investigation.

The Airboat Association of Florida has been in existence for fifty-four years and has used this property as their base since at least 1952. The significance of this organization should not be overlooked. A more definitive determination of NRHP eligibility can be made when an architectural historian can study the buildings on the property in detail and confirm their age as well as complete more research into their history and accomplishments. Information on the organization should be gathered by examining the records of the Airboat Association of Florida, which are stored on their property. Documents might

include minutes of board meetings, newspaper clippings, and photographs. Without access to the site needed to complete this research, the Airboat Association of Florida is recommended potentially eligible for the NRHP and should be managed as if it were an eligible property.

Summary and Recommendations

New South completed four tasks in order to conduct a cultural resources study of the Tamiami Trail, these task were: (1) conducting archival research, literature review and interviews with knowledgeable individuals to refine the history and potential resources located in the project area, (2) developing a survey strategy to identify cultural resources in the project area, (3) documenting the historic properties (newly and previously identified) located in the project area and its vicinity, and (4) developing a survey strategy to identify cultural resources in the project area.

Previous investigations in the area by Janus Research (2001) located four historic resources within the project area. These historic resources are: Tamiami Trail (8DA6765), Tamiami Canal (8DA6766), Coopertown Airboat Rides and Restaurant (8DA6767), and Airboat Association of Florida (8A6768). During this time three properties were considered to be potentially eligible to be listed to the National Register of Historic Places (NRHP) with the exception of 8DA6768, Coopertown Airboat Rides and Restaurant.

The Phase I Archaeological Survey was conducted over six areas as having the most potential to excavate shovel tests. These areas (Area A - F) were evaluated for their potential to contain archaeological deposits. None of the six locations tested contained cultural material within the project area, however, all of the areas were documented. Additionally, New South made note of five previously recorded archaeological sites. Three sites, 8DA2225, 8DA2226, 8DA3242 and, 8DA3243 were located outside of the project area.

The Ethnographic interviews were able to document that there is cultural heritage associated with the Everglades as a whole and is not limited to the Tamiami Trail or Canal. Additionally, the ethnographic investigations have established that several culture groups make use of the Tamiami Canal in which to conduct traditional cultural practices. These culture groups include

African Americans, Cuban Americans, White (Caucasian) Sportsmen, Airboating Community, Hispanic Community, Haitian Community, Seminoles and possibly others. In order to fully document the cultural heritage of the Everglades in Dade County, Florida, a research design focused on documenting the cultural heritage of all of the groups who use this area would be appropriate to determine if there is any specific location that can be identified as a traditional cultural property, as well as to assess the Everglades as a whole as a potential TCP.

NSA's architectural historian resurveyed the historic properties within the project area in order to assess them for NRHP eligibility. The 2001 report submitted by Janus Research recommended that three properties (Coopertown Airboat Rides and Restaurant, Tamiami Trail, and Tamiami Canal) were potentially eligible to the NRHP. The FL SHPO concurred with their recommendations. These three properties were reviewed only for changes that may have occurred since 2001. Other structures along the Trail that were either not surveyed or recommended as not eligible to the NRHP by Janus Research in 2001, were reassessed for their NRHP eligibility. The table below includes a list of the properties and NSA's recommendations.

Table1. Summary of the Historic Properties Evaluated.

Site Number	Property Name	NRHP Recommendation
8DA6765	Tamiami Trail	Eligible
8DA6766	Tamiami Canal	Eligible
8DA6767	Coopertown	Eligible (SHPO Concurred)
8DA6768	Airboat Association of FL	Potentially Eligible
8DA10088	Gator Park	Not Eligible

References Cited

Janus Research

2001 *Cultural Resource Assessment Survey for the Tamiami Trail Project Area in Miami-Dade County, Florida*. Prepared for the United States Army Corps of Engineers, Jacksonville District. Prepared by Janus Research, St. Petersburg.

Kelly, Ivonne Rovira

1986 "Tamiami, the Tourism Trail." *Miami Herald*. July 13, 1986, Neighbors, p. 22.

Miami-Dade County Property Appraiser

2005 Available online at <www.miamidade.gov>.

Parker, P. L. and T. F. King

1994 *National Register Bulletin No. 38, Guidelines for Evaluating and Documenting Traditional Cultural Properties*. United States Department of the Interior, National Park Service, Interagency Resources Division, U. S. Government Printing Office.

Tamiami Trail Commissioners and the County Commissioners of Dade County

1928 *History of the Tamiami Trail and a Brief Review of the Road Construction Movement in Florida*. On file, Miami-Dade Public Library.

Appendix D

ENGINEERING APPENDIX

The Engineering Report on the design of the bridges and reconstruction of the roadway will be included in the Final RGRR/SEIS.

H&H Appendix
RMA-2 Modeling of North East Shark River Slough
And
Design High Water Calculation for Tamiami Trail

1. Introduction: As part of the Revised General Reevaluation Report/Supplemental Environmental Impact Statement (RGRR/SEIS) for the Tamiami Trail, the hydraulic modeling that was performed in the previous report was updated. This entailed re-analyzing the Design High Water (DHW) stage for Tamiami Trail and expanding the RMA-2 model to incorporate a larger portion of Everglades National Park (ENP) (Figure 1). The RMA-2 model expansion was performed in order to incorporate the interaction of the S-12's with the east side of ENP resulting from the removal of L-67 Extension (L-67Ext). The previous modeling had used both the L-67Ext and L-31 North (L-31N) levees as no flow boundaries.

2. Existing Structures: Within the boundaries of this project area exists 5 Corps of Engineers (COE) structures (S-333, S-355A, S-355B, S-334, and S-356) and 19 sets of culverts that pass water from the Levee 29 Borrow Canal (L-29BC) south through Tamiami Trail (US 41) into North East Shark River Slough (NESRS). A brief description of these features follow:

A. S-333 is a reinforced concrete, gated spillway with discharge controlled by one cable operated, vertical lift gate. Either the COE Clewiston office or SFWMD Miami Field Station manually controls the operation of the gate. The gate is operated to make releases from Water Conservation Area 3A (WCA-3A) into the Tamiami Canal (L-29BC). This structure has a maximum discharge rate of 1350 cfs. Under the EIS for the Interim Operational Plan (IOP) it was proposed to make modifications to this structure to increase the maximum discharge capacity of the structure to 2000 cfs. This work has not been performed to date but this discharge capacity was used in the analysis.

B. S-355A and S-355B are reinforced concrete, gated spillways with discharge controlled by one cable operated, vertical lift gate. Each structure is capable of a maximum discharge of 1000 cfs. These structures are a part of the MWD project and are designed to pass water from WCA-3B into NESRS. This transfer of water is via the L-29BC and the combination of culverts and a new bridge being proposed by this project along Tamiami Trail. The S-355A and S-355B structures are not currently operated due to stage constraints in the L-29BC.

C. S-334 is a reinforced concrete, gated spillway with discharge controlled by one cable operated, vertical lift gate. Operation of the gate is manually controlled, and the gate is operated to make releases from the L-29BC into the L-31N canal (South Dade conveyance system). This structure has a maximum discharge rate of 1230 cfs.

D. S-356 is a 500 cfs diesel (4 pumps at 125 cfs each) driven pump station that pumps water from the L-31N canal into the L-29 BC for the purpose of protecting the Cape Sable Seaside Sparrow and for returning increased seepage water from NESRS into L-31N due to the implementation of the MWD Project.

E. The 19 sets of culverts are made up of a total of 54 barrels with diameters ranging in size from 48 to 60 inches (Table 1). A general hydraulic analysis was performed on the culverts to determine the total discharge capacity based on assumed upstream and downstream stages across Tamiami Trail (Table 2). This analysis took into consideration partial flow through the culverts.

3. Limitations of the Current Culvert System: The culvert analysis in Table 2 shows that the current system has the hydraulic capacity to convey the required flows for this project. The hydraulic head required to deliver this quantity of water however, has detrimental impacts to both Tamiami Trail and more importantly WCA-3B. This increased head would require that Tamiami Trail be raised higher than proposed, with only the culverts to convey water. In addition, the compounded head loss from the culverts and the S-355's would result in higher stages and longer durations within WCA-3B, causing detrimental impact to the ecosystem within this area. The other limitation of the culverts is that they provide only point source discharge in an area where the goal of the project is to restore historic sheet flow. The ultimate goal for the restoration of the Greater Everglades Area is to make man-made features (such as roads, levees, canals, etc) transparent to the movement of water.

4. Current Operations: The discharges into the L-29BC (limited currently to S-333) are limited by stages that would cause impact to the current roadway (elevation 7.5 ft, NGVD). This elevation is based on communications with the Florida Department of Transportation (FDOT). Discharges are additionally constrained based on stages at G-3273 (elevation 6.8 ft) for the protection of the 8.5 Square Mile Area. L-29BC is used for two separate purposes:

A. Water Supply Releases: S-333 can be used in conjunction with S-334 to make water supply releases to south and east Dade County (South Dade Conveyance System). The total delivery will be the amount necessary to maintain the appropriate stages at S-331, S-25B and S-22.

B. Regulatory releases from WCA-3A to ENP are made from S-333 and the S-12's. The structures will be operated in accordance with the Interim Operation Plan (IOP, 2002). When water levels at G-3273 (a stage recorder located to the west and north of the 8.5 Square Mile Area) have been above 6.8 ft, NGVD for 24 hours, S-333 will be closed.

5. Expected Flows from Combined Structural and Operational Plan (CSOP): CSOP is looking at combining the Modified Water Deliveries (MWD) Project and the C-111 Project operations in a consistent manner to enhance water deliveries to ENP while maintaining the other authorized purposes of both projects. Currently CSOP is evaluating several alternatives that will provide flows to North East Shark River Slough (NESRS). The average annual flows delivered across Tamiami Trail for the different CSOP alternatives evaluated are summarized in Table 3. These flows are computed at two separate transects within the South Florida Water Management Model (SFWMM or 2x2). Transect 17 represents flows west of S-333 and transect 18 represents flows to the east of S-333. The table illustrates the wide range of average annual discharges into Shark River Slough (SRS) that different operational and structural combinations can produce (ranges from 795 kAF to 1158 kAF). Due to uncertainties of which alternative the CSOP study will select, it was decided that the Natural System Model (NSM 4.6.2) would be used for the design

high water for the roadway improvements. This model run was chosen because it represents our restoration stage and duration targets for the Greater Everglades System.

6. Natural System Model (NSM) [<http://www.sfwmd.gov/org/pld/hsm/models/nsm/index.html>]: The Natural System Model (NSM) attempts to simulate the hydrologic response of the pre-drainage Everglades using recent (1965-2000) records of rainfall and other climatic inputs. The NSM does not simulate the hydrologic response of the natural system prior to influence by man but rather its hydrologic response due to the most recent climatic inputs. Although one may wish to recreate hydrologic conditions of the late 1800's or early 1900's, climatic and other data necessary to perform such a simulation do not exist. The use of recent historical records of rainfall and other inputs allow modelers to make meaningful comparisons between the responses of the current managed system to that of the natural system under conditions of identical climatic inputs. In this sense, the NSM can be a useful planning tool for restoring hydrologic conditions of the natural Everglades.

The landscape of present day south Florida has been greatly affected by land reclamation, flood control and water management activities, which have occurred since the early 1900's. The NSM, in its current form, attempts to simulate the hydrologic system as it would function today without the existence of man's influence. The complex network of canals, structures and levees are replaced with the rivers, creeks and transverse glades that were present prior to the construction of drainage canals. Vegetation and topography used by the NSM are based on pre-drainage conditions. Landcover simulated by the NSM is static. The NSM model does not attempt to simulate vegetation succession, a primary feature in other landscape models currently under development (Everglades Landscape Model, 1994).

The NSM model boundary encompasses an area from Lake Istokpoga to Florida Bay (Figure 2). The western boundary extends southward from Lake Istokpoga to near the Gulf of Mexico, and continues along the coastal marsh fringe, turning southward to Florida Bay near Shark River Slough. The eastern boundary extends across the northern Indian Prairie Region to the Kissimmee River, and continues around the northern rim of Lake Okeechobee to the eastern most point on the lake, turning eastward to the Atlantic Ocean. The eastern boundary then follows the coastline southward to Biscayne Bay and Florida Bay.

Input data to the NSM can be classified as either static or time variant. Static data describes physical features within a cell, including vegetation, land surface elevation, aquifer properties, and river location. The NSM responds to time variant hydrologic stimuli, including rainfall, potential evapotranspiration and inflow at the model boundary.

The NSM was developed from the South Florida Water Management Model (SFWMM) by removing the structures and canals and adding historical drainage features where applicable (i.e. transverse glades). Similar to the SFWMM, the NSM is based on a 2-mile by 2-mile grid that takes into account rainfall, evapotranspiration, topography, subsidence, as well as other hydrologic and hydraulic factors.

The NSM model predicts daily average stages based on simulating observed rainfall data from the years 1965 to 2000 (Figure 3 depicts the stage hydrograph of this period of record

simulation). A stage frequency curve at the location of Tamiami Trail was produced using the COE program Flood Frequency Analysis (FFA), based on the peak daily (24-hour) stage output during the 36 year modeled period of record (Figure 4). The water stages predicted by the NSM would account for the full range of possible seepage and conveyance feature configurations that are being considered for the Combined Structural and Operational Plan (CSOP) and subsequent Comprehensive Everglades Restoration Plan (CERP) WCA 3A/3B Decompartmentalization project. This approach is believed a more prudent design for Tamiami Trail because the design would be compatible with future restoration projects that are part of CERP. For validation of this approach, Figure 5 compares stage duration curves for several future as well as CSOP model runs against the NSM simulation. This figure shows that the NSM stage levels at Tamiami Trail are higher than those expected based on current CSOP and CERP modeling, representing a conservative approach to the design high water for the pavement design.

7. Design High Water (DHW): The Corps of Engineers (COE) has held two teleconferences this year (January 25 and February 15, 2005) with the FDOT, to discuss the design high water (DHW) for the 10.7 miles of roadway between S-333 and S-334. Based on recommendations from the FDOT, COE staff has requested official acceptance by the FDOT of using the 20-year 24-hour stage (9.7 feet, NGVD 1929) for the DHW for the pavement design. The design high water for the over topping criteria will be based on the 100-year stage (10.1 feet, NGVD 1929). These stages represent the expected stages from the NSM model. Figure 4 shows the frequency curve for this portion of Tamiami Trail.

8. L-29BC Recession Rates: Inundation of the sub-grade for extended periods of time can cause quicker degradation of the road surface. The expected recession rates for the L-29BC were computed based on the highest stage from the period of record model, which occurred between October and December 1999. This time period corresponds to when Hurricane Irene passed over the project area. Figure 6 shows the stage hydrographs for 5 different model scenarios for this time period as well as the historical stages during this period. The 5 different model scenarios include: the NSM, 2x2 CERP1 (full CERP build out), 2x2 CSOP Alternative 3, 2x2 CSOP Alternative 4, and 2x2 Alternative 7R5 (Existing Conditions). Recession rates ranged from 0.02 ft/day (NSM Model) to 0.046 ft/day (CSOP Alternative 4).

9. Objective of RMA-2 Modeling: The objective of this modeling analysis is to evaluate the velocity distribution south of the Tamiami Trail (US 41) and stage impacts that different bridge configurations will produce in North East Shark River Slough (NESRS). The goal of the Tamiami Trail Bridge is not only to pass an increased amount of flow into NESRS but also to create a more natural flow pattern (sheet flow) into NESRS. Velocities in excess of 0.1 ft/sec within ENP are assumed to be excessive and destructive to the ridge and slough processes of the Everglades. L-29BC stage impacts due to flow expansion based on bridge width.

10. RMA-2 Model Parameters: Conditions within ENP were modeled using RMA2, the depth-averaged hydrodynamic model of the Corps' TABS-MD modeling system. The model solves the depth-averaged (2D) nonlinear Navier-Stokes equations using an eddy viscosity turbulence closure. The Newton-Raphson iterative approach is used to solve the nonlinear equations. The model uses a fully implicit Galerkin finite element formulation, allowing for time steps as large as the variation in boundary forcing dictates.

A. Material Specification: Six different material types were assigned within the model based on land features (Table 4). These land features varied from the marsh too the L-29 Borrow Canal.

B. Roughness Specification: Table 4 lists the corresponding land type with the Manning's N-value used. Where the variable with depth coefficient was used, the model utilized an equation for bottom roughness as a function of water depth equation. The mathematical form of the dependence of the Mannings friction coefficient with depth is

$$n = \frac{n_0}{d^\alpha} + n_v e^{-d/d_0} \quad (1)$$

where d = water depth
 n₀ = scaling friction factor for depth dependence
 n_v = scaling factor for exponential decay dependence (vegetative effects)
 α = exponent on depth dependence
 d₀ = reference depth for exponential decay

Figure 7 Illustrates the depth dependence curve for the four material types that use this function. All four material types with a variable n-value used the same depth dependence curve.

C. Topography: The model topography was developed from the best available data within the area. These sources included the USGS Helicopter Survey, the USGS Topometric Truck Survey, the SFMWD 5' Contour, and NHAP aerial photography (50's-60's). In addition several Corps of Engineers surveys of L-29 Borrow Canal were used to approximate the canal invert. The accuracy of the data is approximately 0.5 feet.

D. Culvert Locations: Culvert locations were approximated as gaps through Tamiami Trail. These locations were set to the same elevation as the marsh downstream of the culvert. To account for the increased area and ease of flow, the Manning's n-value was set higher than what would be typically used for a culvert structure. Based on limitations of the model to not exceed a 50 percent change in area between elements (the base grid along the south side of Tamiami Trail is 200 feet by 200 feet), the culvert's were approximated as 12.5 feet wide. All culvert structures were approximated to the same width. Figure 8 is a figure of the model mesh in the vicinity of one of the culverts through Tamiami Trail.

E. Boundary Conditions: The model uses two types of boundary conditions, 1) boundary discharge lines and 2) boundary head lines. Boundary discharge lines were defined for all inflow points along the northern boundary of the model representing all structures. A boundary headline was used along the southern boundary to specify the starting water surface elevations from gage P-36. To determine the flows and stage for the model runs, a frequency analysis using the Log Pearson Type III Distribution was performed on the West Bookend Run (CSOP dated 010405 v5.5.4). Table 5 lists the results of this analysis and Table 6 lists the distribution of flow from west to east into ENP based on the frequency analysis. Steady

state simulations were performed for the following return period discharges: 1, 2, 5, 10, 20, 25, 50, and 100 year events.

F. Structures Location: All structures and culverts were located in the general proximity of the real world coordinates plus or minus 100 feet based on the mesh configuration of the model. The new weirs on the L-29 levee are based on the centerline locations of the previous CSOP model runs for Water Conservation Area 3B.

11. Alternatives: 5 Different Bridge alternatives were modeled. Figure 9 shows the alternative bridge location transposed over elevations along a cross section taken approximately 1000 feet south of the trail.

A. Existing Conditions (No Action): This model run represents the distribution of flow south of Tamiami Trail as if no bridge was added to this portion of road. This is a planning condition run that is not feasible due to impacts to Tamiami Trail and Water Conservation Area 3B.

B. 3000-foot Bridge: The Bridge is located between the Blue Shanty Canal and the Airboat Association (Same as previous report). This will not affect any of the culverts through Tamiami Trail.

C. 4-mile Bridge East: The 4 mile bridge is located on the east side starting approximately 200 feet west of structure S-334. The western terminus will be near Cooper's Town. This alternative will remove 8 of the 19 culverts beneath Tamiami Trail.

D. 4-mile Bridge West Central: The 4 mile bridge is located in the center between structures S-333 and S-334 starting on the east side of the Blue Shanty Canal and extending east 4 miles (Same as previous report). This alternative will remove 9 of the 19 culverts beneath Tamiami Trail.

E. 10.7-mile Bridge: This Bridge spans the length of Tamiami Trail from S-333 to S-334 (Approximately 10.7 miles). The bridge abutments will begin approximately 200 feet east and west of S-333 and S-334, respectively, too allow flows to become less turbulent before reaching the beginning of the bridge. This alternative will remove all 19 culverts beneath Tamiami Trail.

F. 2-mile West Bridge and 1-mile East Bridge: The 2 mile bridge on the west side starts approximately 0.5 mile east of the Osceola Camp and proceeds east. The 1 mile bridge on the east side is placed in between the two wood stork colonies on the east side of the project approximately an equal distance from each individual buffer area.

G. 1-mile West Bridge and 1-mile East Bridge:

H. 1.3-mile West Bridge and 0.7-mile East Bridge:

I. 3 – 3000 foot Bridges:

J. 2-mile Bridge West:

K. 3-mile Bridge West:

L. 2-mile Bridge West and 2-mile Bridge East:

12. RMA-2 Results: Several different results were analyzed from the RMA-2 Model output as part of the benefits analysis. A brief description follows for each set of information.

A. For each alternative, the velocity at the center of the bridge for the 100-year computed flows was compared to the marsh velocity at a distance of approximately 10,000 feet downstream of the road from the 10.7-mile bridge option. Velocities for these return periods are depicted in Figures 10 and 11, respectively. The target is to minimize the difference in velocity between the bridge and the marsh. The higher velocities produced by the shorter bridge are extremely destructive to the ridge and slough environment of the Everglades immediately south of the Tamiami Trail.

B. For each alternative the area with velocities above 0.1 feet per second was computed. This allowed for a comparison of which alternatives would produce the least amount of impacted area (Table 7). The calculations for the area are based on the area immediately south of Tamiami Trail and east of S-333.

C. To measure the expansion losses at each bridge a stage difference was computed between the L-29BC and a point within the marsh 10,000 feet downstream of the center of the bridge (See Figure 12). The objective of the bridge opening is to minimize the head differential (dH) between these two locations. The L-29BC acts as a stage equalizer upstream of the roadway embankment but the expansions losses downstream of the bridge due to water flowing away from the bridge opening dictates the stage in the borrow canal. This increased stage is then propagated into Water Conservation 3B as we try to move water through this area with the use of the S-355's and potentially other structures (a stage increase of $dH + dS$).

13. Enhancement of Flow from L-29 Canal into the Deeper Sloughs of NESS: While the existing culverts provide a hydraulic connection to the deeper sloughs existing within Northeastern Shark Slough (NESS) the capacity is not commensurate with amount of flow expected in these deeper sloughs during both high and low flow conditions. Preferential flow through these deeper sloughs is even more pronounced during drier times.

As can be seen in Figure 8, the eastern portion of Shark Slough (from the L-67A extension to the L-31N levee) varies in elevation from about 5.6 feet NGVD to 7.2 feet NGVD. Without the obstruction of Tamiami Trail the preferential flow path resulting from this varying elevation would be in the deeper sloughs. Figure 1 shows the relative marsh capacity for a stage of 7.5 feet NGVD, which represent a typical transitional condition when the highest areas are only slightly inundated. The distribution of flow within northeast Shark Slough will become more uniformly distributed (from West to East) as depth increases and the relative depth differences

reduce. The 7.5 feet NGVD stage is within two tenth of the median value for the No Action and Alternatives 1 through 4 of the Combined Structural and Operational Plan (CSOP) for the Modified Water Deliveries to Everglades National Park (MWD ENP) and the C-111 Canal projects.

A. Average and High Flow Conditions: The stages in northeast Shark Slough range from about 4 feet NGVD (about 2 feet below ground surface) to 9 feet NGVD with a median stage of about 7.5 feet NGVD. As can be seen in Figure 1, the stage of 7.5 feet NGVD results in an average depth of about 1.1 feet with a maximum depth of about 1.9 feet and a minimum depth of about 0.3 feet

The increased connection provided by the bridge aligned with deeper portions of northeast Shark Slough facilitates increased flow where it should occur preferentially. As can be seen in Figure 1, with the water level less than 0.5 above the ridges most of the flow occurs in the deeper sloughs. It is important for water to be rapidly delivered to these deeper sloughs, commensurate with this capacity, during wet periods to produce higher velocities desirable for the redevelopment and maintenance of open water vegetation in these sloughs. This assessment assumes that sheet flow is based on the following equations

Manning Equation; $Q = (u/n) A R h^{(2/3)} (h_f / L)^{(1/2)}$
A depth dependent Manning n ($n = \sim d^{-0.77}$)

Where:

A = Cross Section Flow Area = W * d
W = Flow Width
d = Flow Depth
P = Wetted Perimeter
R = Hydraulic Radium = A/P = (W * d) / W ~ d

B. Dry Conditions: During dry periods these deeper sloughs will have meaningfully deeper levels. The importance of these connections during drier periods is increased by the fact that both the existing condition and the expected range of the “with project” conditions (Tamiami Trail Bridge in conjunction with CSOP Operations) are drier than the desired conditions as represented by the Natural System Model (NSM). Specifically, NSM Version 4.6 predicts that the water levels would be at or below ground surface for approximately 2% of the time whereas as the existing conditions (ALT7R5) and alternatives (1 through 4) range from 8% to 11% percent of the time. The CERP reduces these dry conditions to 4% of the time. The increased connection that a bridge provides over culverts in terms of capacity and connectivity (sheet flow with low velocity versus flow through culverts) is expected, for the same water availability, to have the following benefits:

- Better distribution of the water; high water levels with more natural recession rates and less abnormal dry out as the limited water available can reach these sloughs.
- Facilitates the movement of fish into the L-29 canal through the deepest portions of Northeastern Shark Slough during dry outs which allows for rapid repopulation of these sloughs.

- Reduces unnatural predation around the culverts due to their limited area.

C. Evaluation Procedure: The benefits of different bridge lengths and locations were assessed considering each bridge location. A representative “marsh capacity” was estimated on 200 foot wide intervals using the USGS helicopter ground elevations and Manning’s “n” based flow equation used in the South Florid Water Management Model (SFWMM). The location of each bridge is then used to calculate the marsh capacity directly connected by a bridge opening. This marsh capacity for the bridge is then divided by the marsh capacity of the approximately 11 mile wide northeast Shark Slough from the L-67 Extension to the L-31N levee (NAD83 horizontal coordinates from 763,500 to 821,250) and expressed as percentage. The full bridge option with 0.3 mile long ramps at each end (ending 0.3 miles West of S-334) had a total bridge length of 10.1 miles and encompassed 91% of the entire marsh capacity.

TABLES

Table 1
INVENTORY OF CULVERTS ALONG U.S. 41(TAMIAMI TRAIL)
INFORMATION PROVIDED BY FDOT (RICARDO SALAZAR-DRAINAGE SECTION)

FDOT HEADWALL STRUCTURE NAME			DIST. FROM U/S TO D/S STATION STRUCTURE		PIPE LENGTH	PIPE DIA.	INLET INVERT	AVE. INLET	OUTLET	AVE. OUTLET	TOP OF	
U/S	D/S	OF CL	(ft)	EL.(ft)	(ft)	(inches)	EL.(ft)	INVERT EL.(ft)	INVERT EL.(ft)	INVERT EL.(ft)	EL.(ft)	CULV. EL. (ft)
COE S-333		732+10.0	1027.5	-	-	-	-	-	-	-	-	-
S-1	S-2	752+57.0	3083.5	10.90	61.6	54	4.68		5.02			
S-1	S-2	752+65.0			61.6	54	4.76	4.7	5.04	5.0	9.2	
S-1	S-2	752+72.0			61.6	54	4.68		4.90			
S-3	S-4	793+69.0	4045.0	10.95	61.0	60	4.35		4.59			
S-3	S-4	793+77.0			61.0	60	4.09	4.4	4.55	4.5	9.4	
S-3	S-4	793+86.0			61.0	60	4.69		4.38			
S-5	S-6	833+46.5	3507.0	10.76	61.0	60	3.76		4.06			
S-5	S-6	833+55.0			61.0	60	3.80	3.8	4.20	4.2	8.8	
S-5	S-6	833+64.0			61.0	60	3.89		4.34			
S-7	S-8	863+83.0	2809.5	10.77	62.0	54	3.82		3.89			
S-7	S-8	863+91.0			62.0	54	3.86	3.8	3.99	4.0	8.3	
S-7	S-8	863+98.5			62.0	54	3.85		4.06			
S-9	-	889+65.5	3121.5	10.86	85.0	60	4.25		-			
S-9	-	889+74.0			85.0	60	4.16	4.2	-	-	9.2	
S-9	-	889+82.5			85.0	60	4.28		-			
S-10	S-11	926+27.0	3116.5	10.79	60.5	48	3.79		4.06			
S-10	S-11	926+34.0			60.5	48	3.23	3.6	3.99	4.1	7.6	
S-10	S-11	926+40.5			60.5	48	3.73		4.13			
S-12	S-13	951+99.0	3071.0	10.94	61.5	60	4.14		4.05			
S-12	S-13	952+07.0			61.5	60	4.09	4.1	4.02	4.0	9.1	
S-12	S-13	952+16.0			61.5	60	4.08		4.03			
S-14	S-15	987+67.5	3715.5	10.87	61.0	54	4.90		4.95			
S-14	S-15	987+76.0			61.0	54	5.02	4.9	4.90	4.9	9.4	
S-14	S-15	987+84.5			61.0	54	4.91		4.73			
S-16	S-17	1026+30.0	2648.0	10.66	62.7	60	1.93		2.36			
S-16	S-17	1026+38.0			62.7	60	2.42	2.2	2.35	2.4	7.2	
S-16	S-17	1026+46.0			62.7	60	2.20		2.42			
S-16	S-17	1026+55.5			62.7	60	2.18		2.34			
S-18	S-19	1040+63.5	2157.9	10.58	62.0	60	3.02		3.11			
S-18	S-19	1040+72.0			62.0	60	2.85	3.0	3.08	3.1	8.0	
S-18	S-19	1040+80.5			62.0	60	3.08		3.22			
S-20	S-21	1069+54.8	2946.5	10.65	61.0	48	4.08		4.08			
S-20	S-21	1069+61.7			61.0	48	4.11	4.1	4.06	4.1	8.1	
S-20	S-21	1069+68.0			61.0	48	4.16		4.03			
S-22	S-23	1099+65.0	1750.4	11.20	61.5	60	2.90	2.9	3.05	3.1	8.6	
S-24	S-25	1104+53.5	1461.2	11.13	60.5	60	3.84		3.71			
S-24	S-25	1104+62.5			60.5	60	3.72	3.8	3.55	3.6	8.8	
S-24	S-25	1104+71.0			60.5	60	3.76		3.65			
S-26	S-27	1128+87.3	2592.8	11.10	60.2	54	3.60	3.5	3.80	3.8	8.0	
S-26	S-27	1128+95.0			60.2	54	3.48		3.81			
S-28	S-29	1156+40.0	2774.3	11.22	62.8	60	4.14		4.25			
S-28	S-29	1156+48.0			62.8	60	4.02	4.1	4.08	4.2	9.1	
S-28	S-29	1156+57.0			62.8	60	4.14		4.22			
S-30	S-31	1184+37.5	3256.4	10.78	61.0	48	3.48		3.35			
S-30	S-31	1184+43.5			61.0	48	3.65	3.6	3.32	3.6	7.6	
S-30	S-31	1184+50.0			61.0	48	3.70		4.02			
S-32	S-33	1221+54.0	3620.0	10.92	60.7	48	3.35		3.32			
S-32	S-33	1221+60.7			60.7	48	3.34	3.4	3.31	3.3	7.4	
S-32	S-33	1221+67.9			60.7	48	3.43		3.34			
S-34	S-35	1256+76.0	3040.4	11.32	61.5	42	4.07		4.09			
S-34	S-35	1256+83.5			61.5	42	4.15	4.1	4.08	4.1	7.6	
S-34	S-35	1256+89.0			61.5	42	4.13		4.05			
S-36	S-37	1282+34.8	2060.8	11.58	62.0	48	3.82		3.92			
S-36	S-37	1282+41.4			62.0	48	3.84	3.8	3.95	3.9	7.8	
S-36	S-37	1282+48.4			62.0	48	3.76		3.95			
COE S-334		1298+05.0	781.8	-	-	-	-	-	-	-	-	-

Table 2
MODIFIED WATER DELIVERIES

U.S. 41 CULVERTS
CULVERT DISCHARGE RATING(CFS)

TW EL (FT- NGVD)		ALL CULVERTS BETWEEN S-333 AND S-334 HW EL (FT-NGVD)																																
	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	9.0	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	9.9	10.0	10.1	10.2	10.3
7.0	0	1,234	1,796	2,258	2,672	3,054	3,412	3,754	4,080	4,395	4,695	4,986	5,268	5,541	5,807	6,065	6,316	6,557	6,785	7,005	7,215	7,410	7,595	7,766	7,933	8,097	8,257	8,414	8,569	8,720	8,869	9,016	9,160	9,302
7.1		0	1,270	1,844	2,314	2,732	3,115	3,475	3,817	4,143	4,454	4,754	5,044	5,323	5,595	5,859	6,115	6,361	6,593	6,818	7,032	7,231	7,421	7,595	7,766	7,933	8,097	8,257	8,414	8,569	8,720	8,869	9,016	9,160
7.2			0	1,304	1,889	2,366	2,786	3,172	3,534	3,876	4,200	4,510	4,809	5,097	5,376	5,646	5,908	6,159	6,397	6,626	6,845	7,048	7,242	7,421	7,595	7,766	7,933	8,097	8,257	8,414	8,569	8,720	8,869	9,016
7.3				0	1,336	1,932	2,413	2,837	3,226	3,588	3,928	4,252	4,562	4,860	5,147	5,425	5,693	5,950	6,193	6,428	6,652	6,860	7,058	7,242	7,421	7,595	7,766	7,933	8,097	8,257	8,414	8,569	8,720	8,869
7.4					0	1,366	1,970	2,457	2,885	3,275	3,637	3,977	4,301	4,610	4,908	5,194	5,469	5,734	5,983	6,224	6,453	6,667	6,870	7,058	7,242	7,421	7,595	7,766	7,933	8,097	8,257	8,414	8,569	8,720
7.5						0	1,393	2,006	2,499	2,930	3,320	3,682	4,024	4,347	4,656	4,952	5,237	5,509	5,766	6,013	6,248	6,468	6,677	6,870	7,058	7,242	7,421	7,595	7,766	7,933	8,097	8,257	8,414	8,569
7.6							0	1,419	2,040	2,537	2,970	3,361	3,725	4,066	4,389	4,698	4,993	5,274	5,540	5,794	6,036	6,263	6,477	6,677	6,870	7,058	7,242	7,421	7,595	7,766	7,933	8,097	8,257	8,414
7.7								0	1,443	2,072	2,572	3,007	3,401	3,764	4,106	4,429	4,737	5,029	5,304	5,567	5,817	6,050	6,272	6,477	6,677	6,870	7,058	7,242	7,421	7,595	7,766	7,933	8,097	8,257
7.8									0	1,465	2,100	2,604	3,042	3,436	3,801	4,143	4,466	4,771	5,057	5,330	5,589	5,830	6,059	6,272	6,477	6,677	6,870	7,058	7,242	7,421	7,595	7,766	7,933	8,097
7.9										0	1,485	2,126	2,634	3,074	3,470	3,836	4,177	4,498	4,797	5,082	5,351	5,601	5,839	6,059	6,272	6,477	6,677	6,870	7,058	7,242	7,421	7,595	7,766	7,933
8.0											0	1,503	2,151	2,662	3,104	3,502	3,867	4,208	4,523	4,821	5,102	5,363	5,610	5,839	6,059	6,272	6,477	6,677	6,870	7,058	7,242	7,421	7,595	7,766
8.1												0	1,521	2,173	2,688	3,132	3,531	3,895	4,231	4,545	4,840	5,113	5,371	5,610	5,839	6,059	6,272	6,477	6,677	6,870	7,058	7,242	7,421	7,595
8.2													0	1,537	2,195	2,712	3,158	3,556	3,917	4,252	4,563	4,851	5,121	5,371	5,610	5,839	6,059	6,272	6,477	6,677	6,870	7,058	7,242	7,421
8.3														0	1,552	2,215	2,735	3,181	3,576	3,936	4,268	4,573	4,858	5,121	5,371	5,610	5,839	6,059	6,272	6,477	6,677	6,870	7,058	7,242
8.4															0	1,566	2,233	2,754	3,198	3,593	3,952	4,278	4,580	4,858	5,121	5,371	5,610	5,839	6,059	6,272	6,477	6,677	6,870	7,058
8.5																0	1,579	2,249	2,770	3,214	3,607	3,961	4,284	4,580	4,858	5,121	5,371	5,610	5,839	6,059	6,272	6,477	6,677	6,870
8.6																	0	1,590	2,262	2,783	3,227	3,616	3,967	4,284	4,580	4,858	5,121	5,371	5,610	5,839	6,059	6,272	6,477	6,677
8.7																		0	1,599	2,273	2,794	3,234	3,621	3,967	4,284	4,580	4,858	5,121	5,371	5,610	5,839	6,059	6,272	6,477
8.8																			0	1,607	2,282	2,801	3,239	3,621	3,967	4,284	4,580	4,858	5,121	5,371	5,610	5,839	6,059	6,272
8.9																				0	1,613	2,287	2,805	3,239	3,621	3,967	4,284	4,580	4,858	5,121	5,371	5,610	5,839	6,059
9.0																					0	1,617	2,290	2,805	3,239	3,621	3,967	4,284	4,580	4,858	5,121	5,371	5,610	5,839
9.1																						0	1,619	2,290	2,805	3,239	3,621	3,967	4,284	4,580	4,858	5,121	5,371	5,610
9.2																							0	1,683	2,381	2,916	3,367	3,764	4,123	4,454	4,761	5,050	5,323	5,583

Table 3
Average Annual Overland Flow Across Tamiami Trail
(Transect 17 = WSS and Tansect 18 = ESS)

SFWMM Simulation	Transect 17 1000 acre-ft	Transect 18 1000 acre-ft	SRS Total 1000 acre-ft	% Distribution West East
NSM 4.6.2	477	895	1372	35% / 65%
D13R	434	487	921	47% / 53%
CERP0 *	398	509	907	44% / 56%
Alt7R5	623	172	795	78% / 22%
No Action	376	493	869	43% / 57%
East Bookend	452	516	968	47% / 53%
West Bookend	447	597	1044	43% / 57%
West Bookend (b)	451	683	1134	40% / 60%
Alternative 3	527	631	1158	46% / 54%
Alternative 4	434	540	974	45% / 55%
<div> <div></div> <div>Alternatives to date evaluated by the CSOP process.</div> </div> <div>*CERP0 flows at T18 do not include S-356 flows, which discharges south of T18 into</div>				

Table 4
Model Material Types

Material Number	Land Type	Manning's N-Value
1	Marsh	Variable with Depth
2	L-29BC	0.035
3	Culverts thru Tamiami Trail	0.045
4	Just downstream of Culvert	Variable with Depth
5	Just downstream of S-12's	Variable with Depth
6	marsh along L-31N	Variable with Depth

Table 5
Frequency Analysis Results

Frequency		Tail Water	Western Flows to ENP				Eastern Flows to ENP					
Event	%	NP-36	S-12A	S-12B	S-12C	S-12D	S-333	L-29WA	L-29WB	S-355 A&B	L-29WC	S-356
1.01	99	4.25	19	38	52	126	65	234	197	229	171	125
2	50	5.05	186	378	404	514	356	392	380	554	406	450
5	20	5.35	350	687	704	812	1167	465	434	632	448	500
10	10	5.50	470	897	909	1019	2000	506	457	657	459	500
20	5	5.63	587	1095	1104	1223	2000	542	473	672	464	500
25	4	5.67	625	1157	1164	1288	2000	553	478	675	465	500
50	2	5.77	740	1340	1348	1492	2000	584	488	682	467	500
100	1	5.87	854	1514	1525	1698	2000	614	497	686	467	500
Figure		3	4	5	6	7	*	8	9	10	11	12

Note: * Frequency curve was not performed for this structure. The data did not support this type of analysis. Instead the flows were assumed based on the operating manner of the SFWMM 2 by 2 output.

Table 6
Flow Distribution West to East

Frequency Event (year)	%	Total Flow		Percentage Split		Total Flow (cfs)
		West (cfs)	East (cfs)	West	East	
1.01	99	235	1,021	18.7%	81.3%	1,257
2	50	1,482	2,538	36.9%	63.1%	4,020
5	20	2,553	3,646	41.2%	58.8%	6,199
10	10	3,295	4,580	41.8%	58.2%	7,875
20	5	4,009	4,651	46.3%	53.7%	8,660
25	4	4,234	4,670	47.6%	52.4%	8,904
50	2	4,921	4,721	51.0%	49.0%	9,642
100	1	5,592	4,764	54.0%	46.0%	10,356

Table 7
Acres of Impact above 0.1 ft per second

	Acres Above
1) 3000 ft Bridge	411
2) 4 mi West	98
3) 4 mi Central	336
4) 4 mi East	149
5) 10.7 mi	10
6) No Action	187

FIGURES

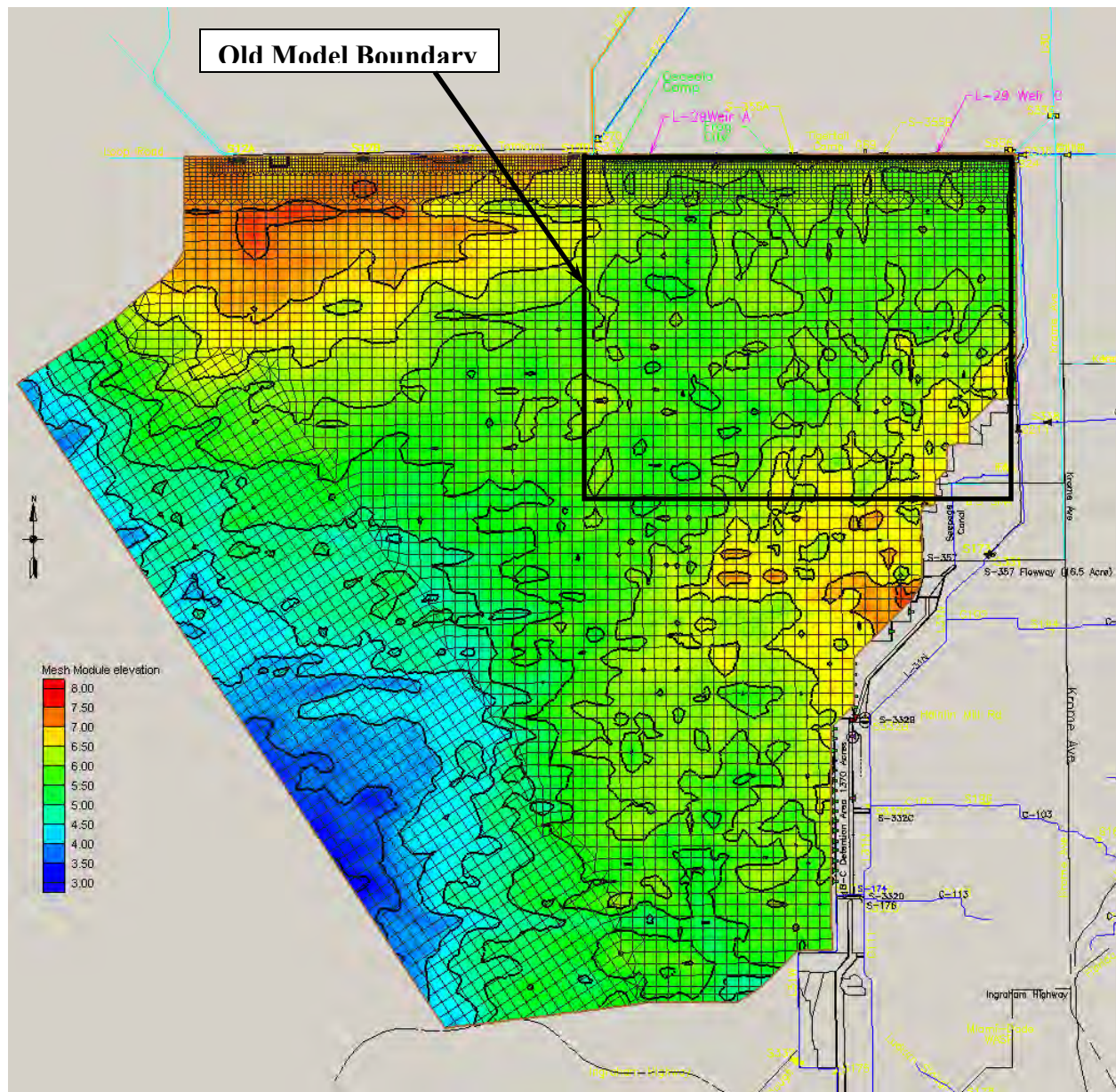


Figure 1 Model Mesh

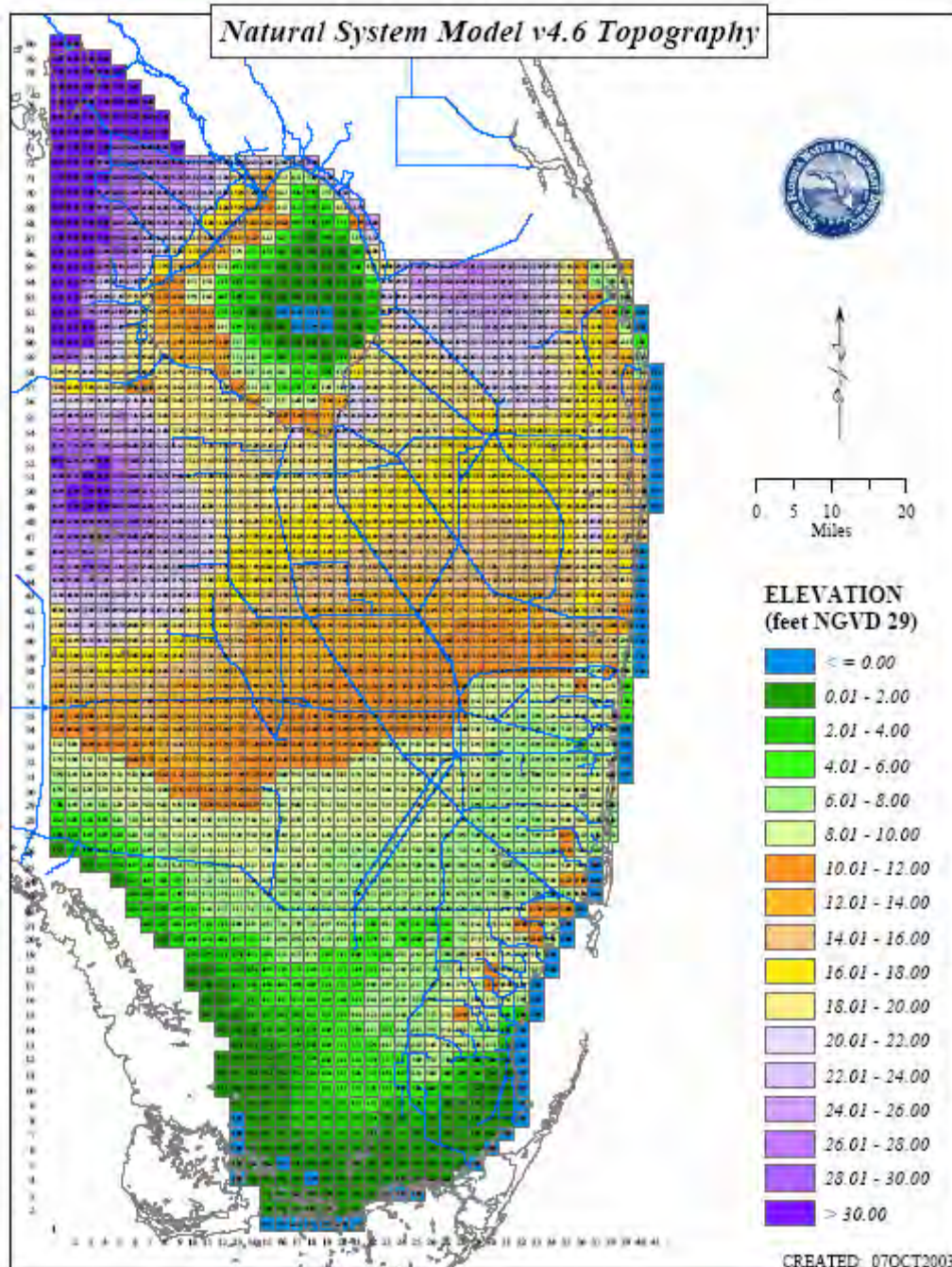


Figure 2 NSM Model Grid (<http://www.sfwmd.gov/org/pld/hsm/models/nsm/index.html>)

Stage Hydrograph of NSM Model Output along Tamiami Trail Location

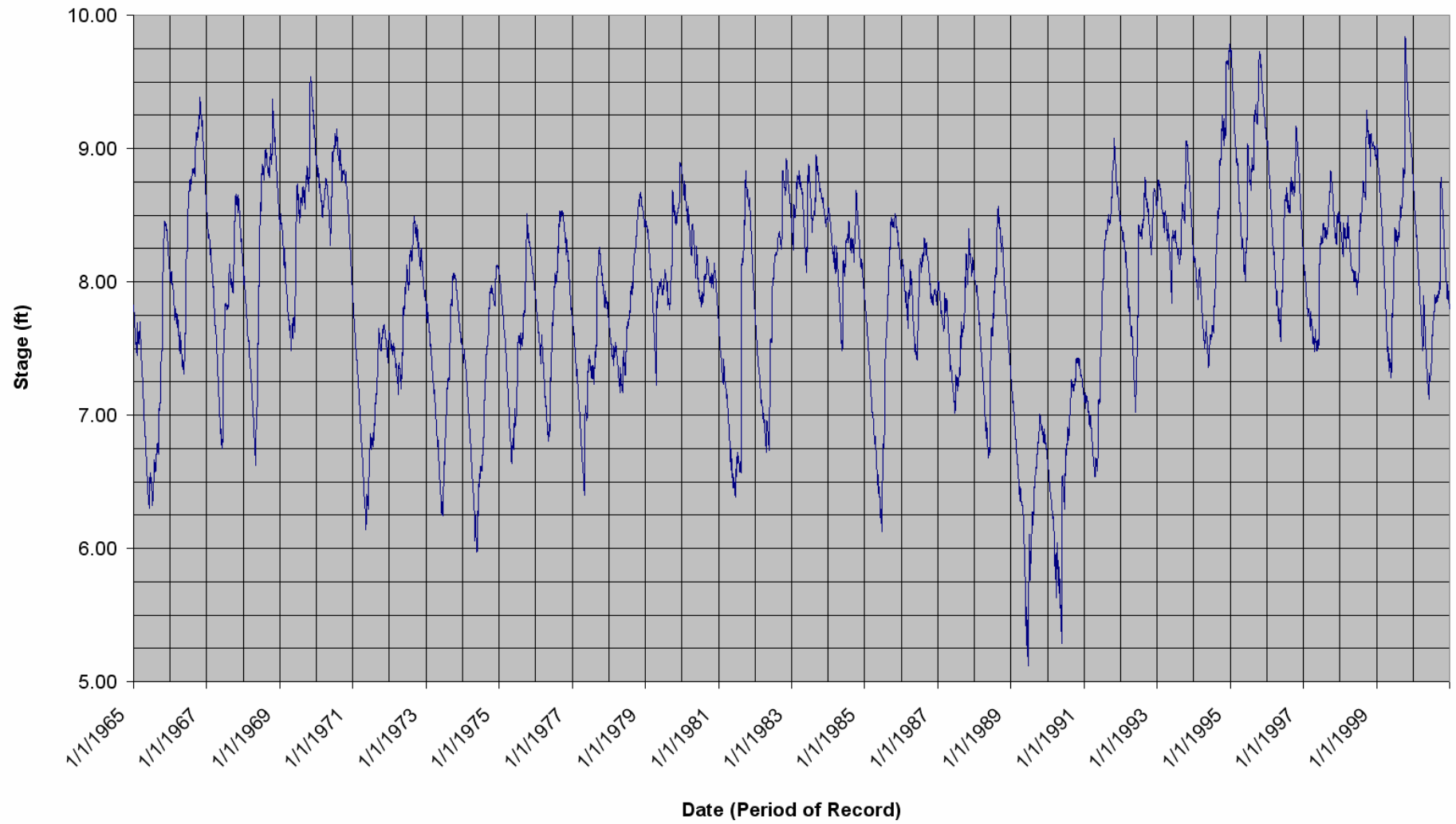


Figure 3 Stage Hydrograph of Natural System Model Output along Tamiami Trail

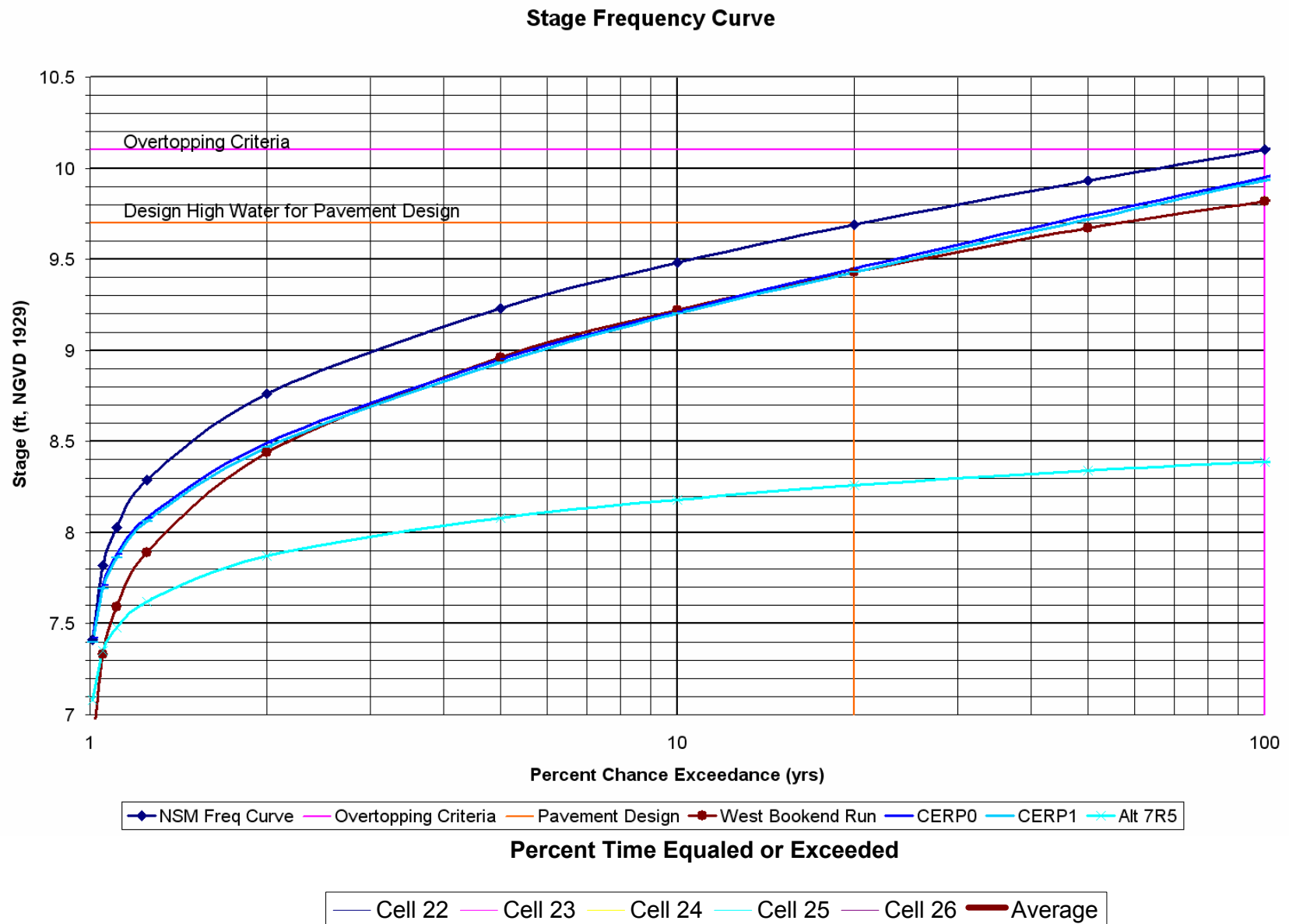


Figure 4 Frequency Curve From Natural System Model (NSM)

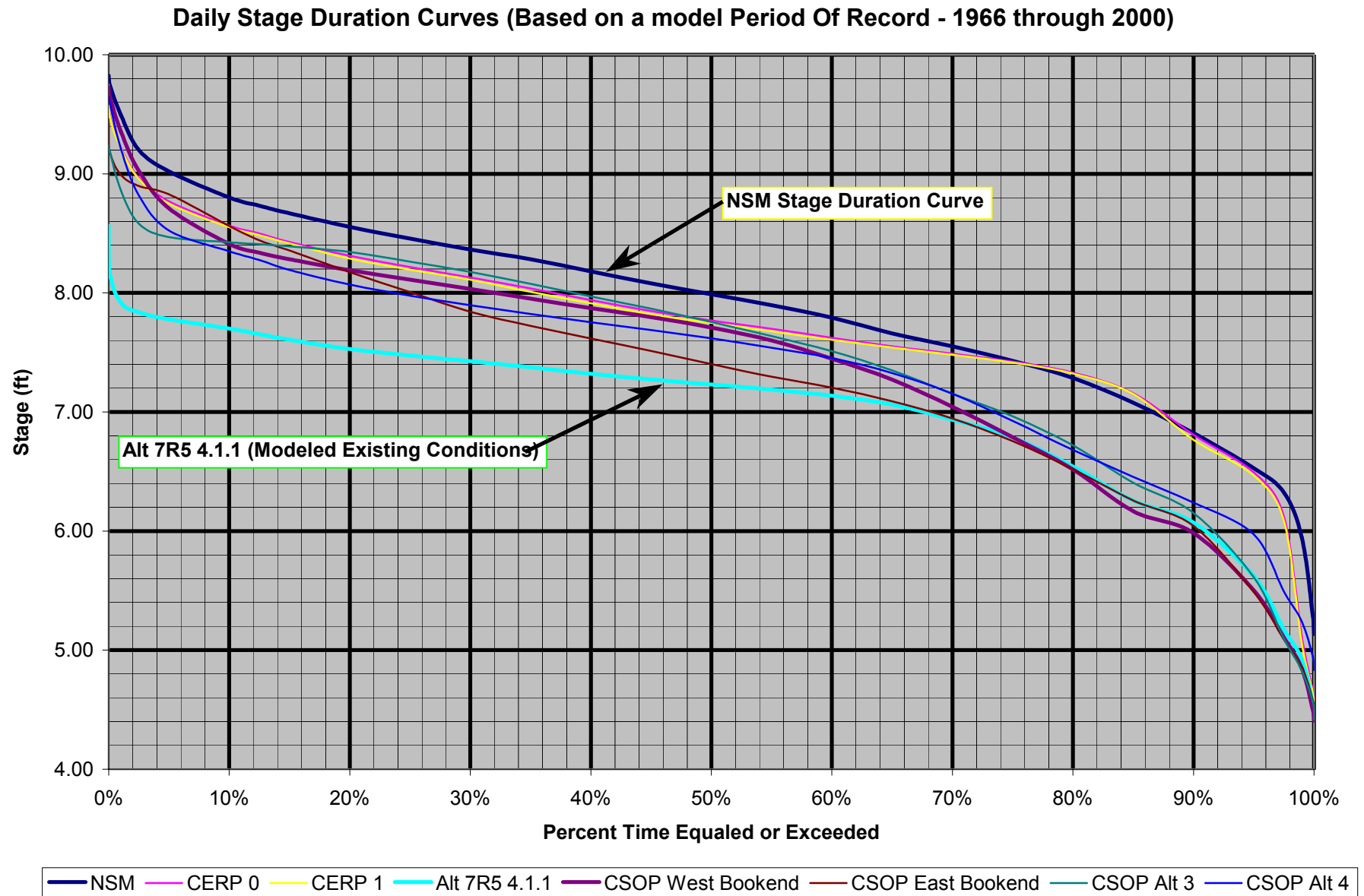


Figure 5 Daily Stage Duration Curve for Various 2 by 2 Runs

Stage Hydrograph for L-29 during Hurrican Irene Based on several Computer Simulations

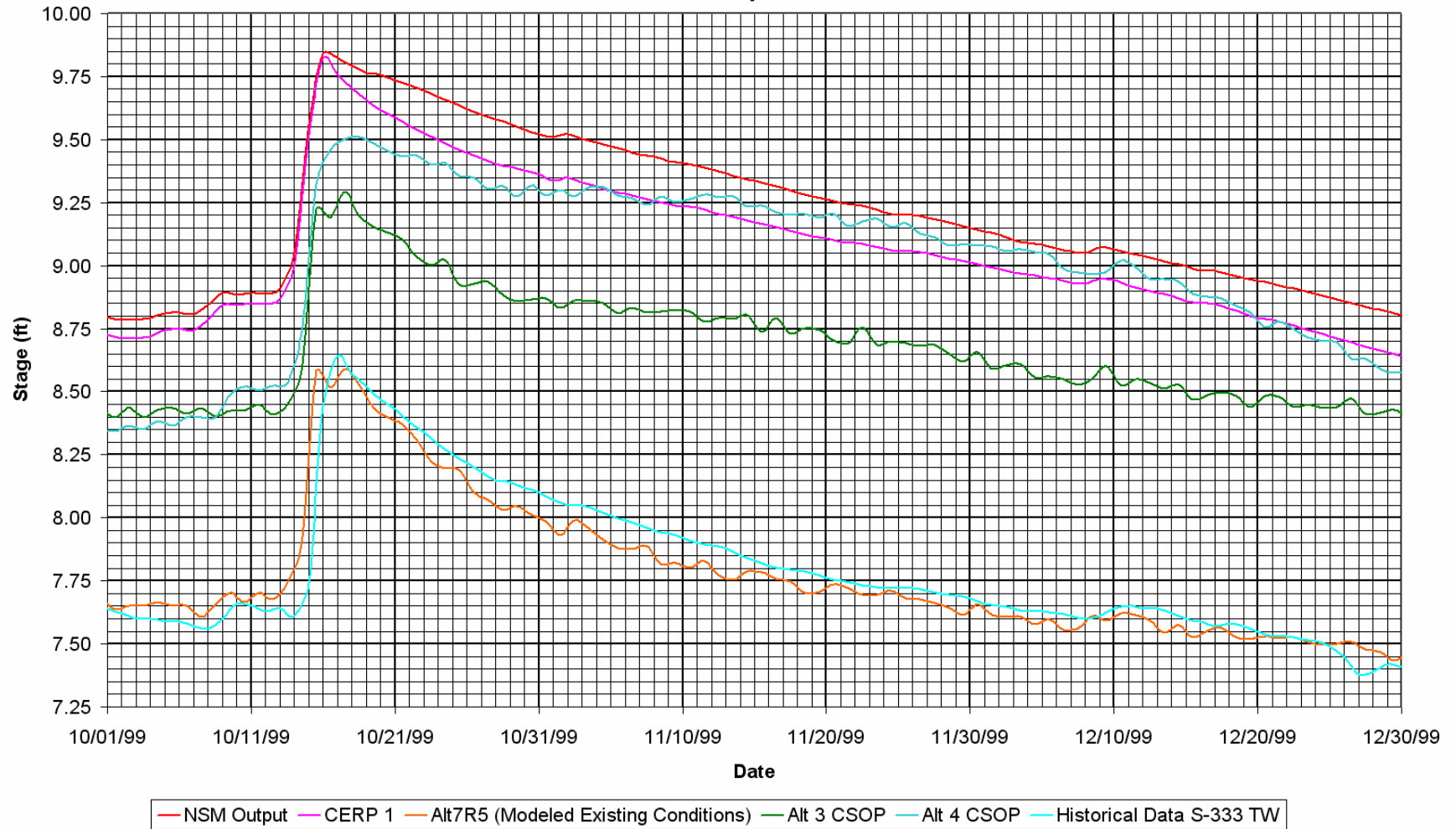


Figure 6 Stage Hydrograph Showing Recession Rates During Hurricane Irene

Depth Dependence of Friction Coefficient

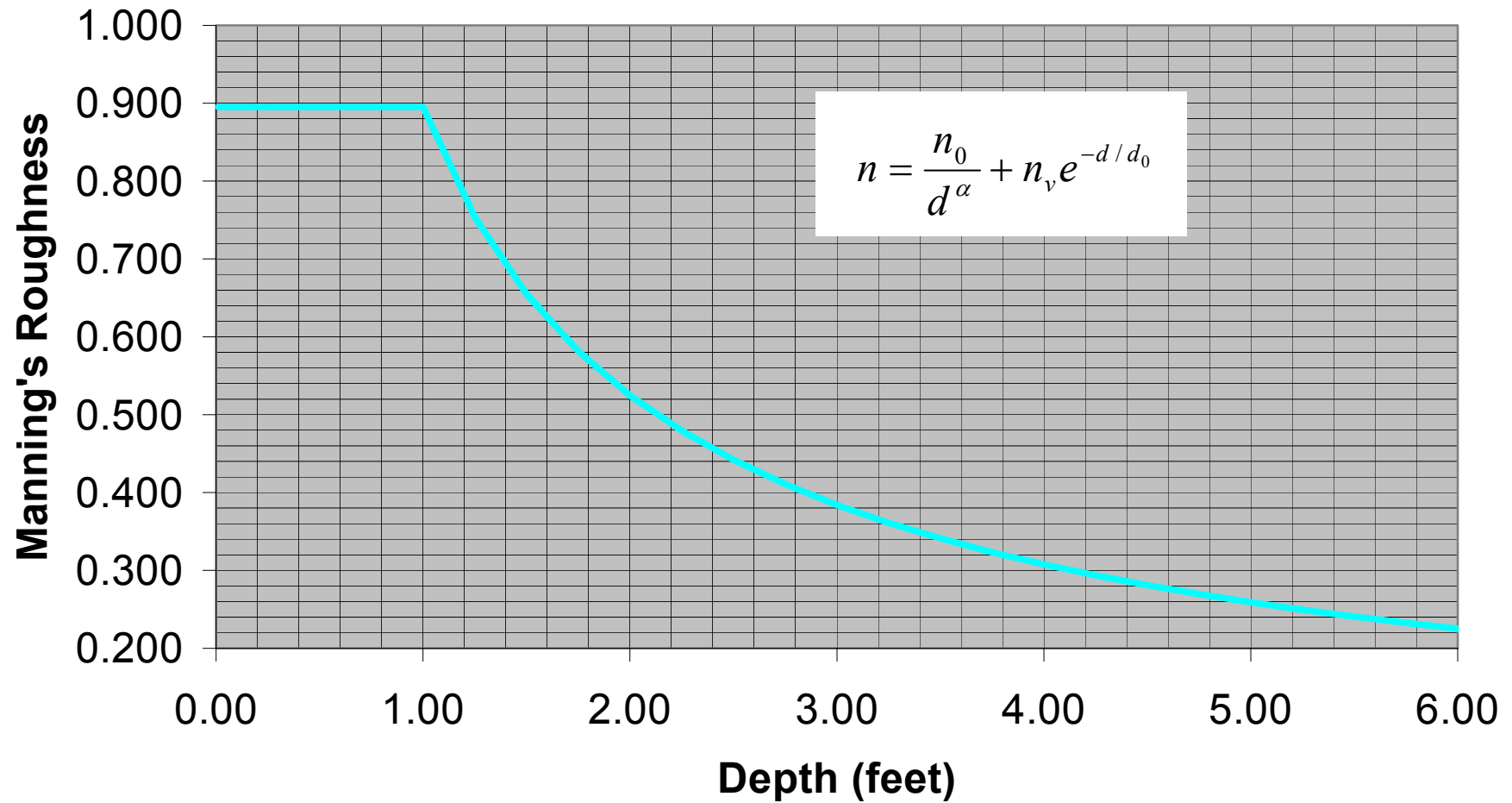


Figure 7 Depth Dependence Friction Coefficient for RMA-2 Model

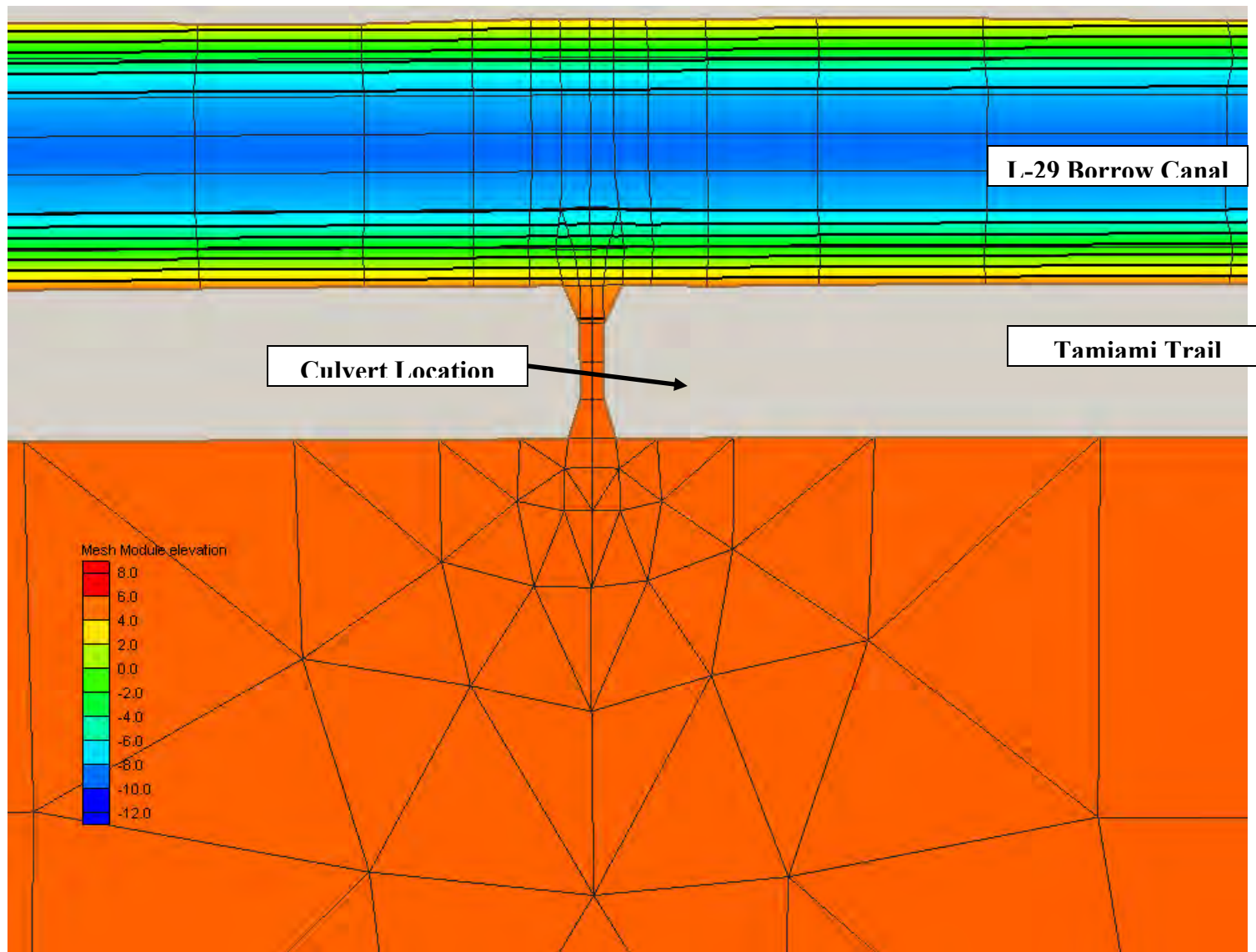


Figure 8 RMA-2 Mesh Geometry at Culvert Location

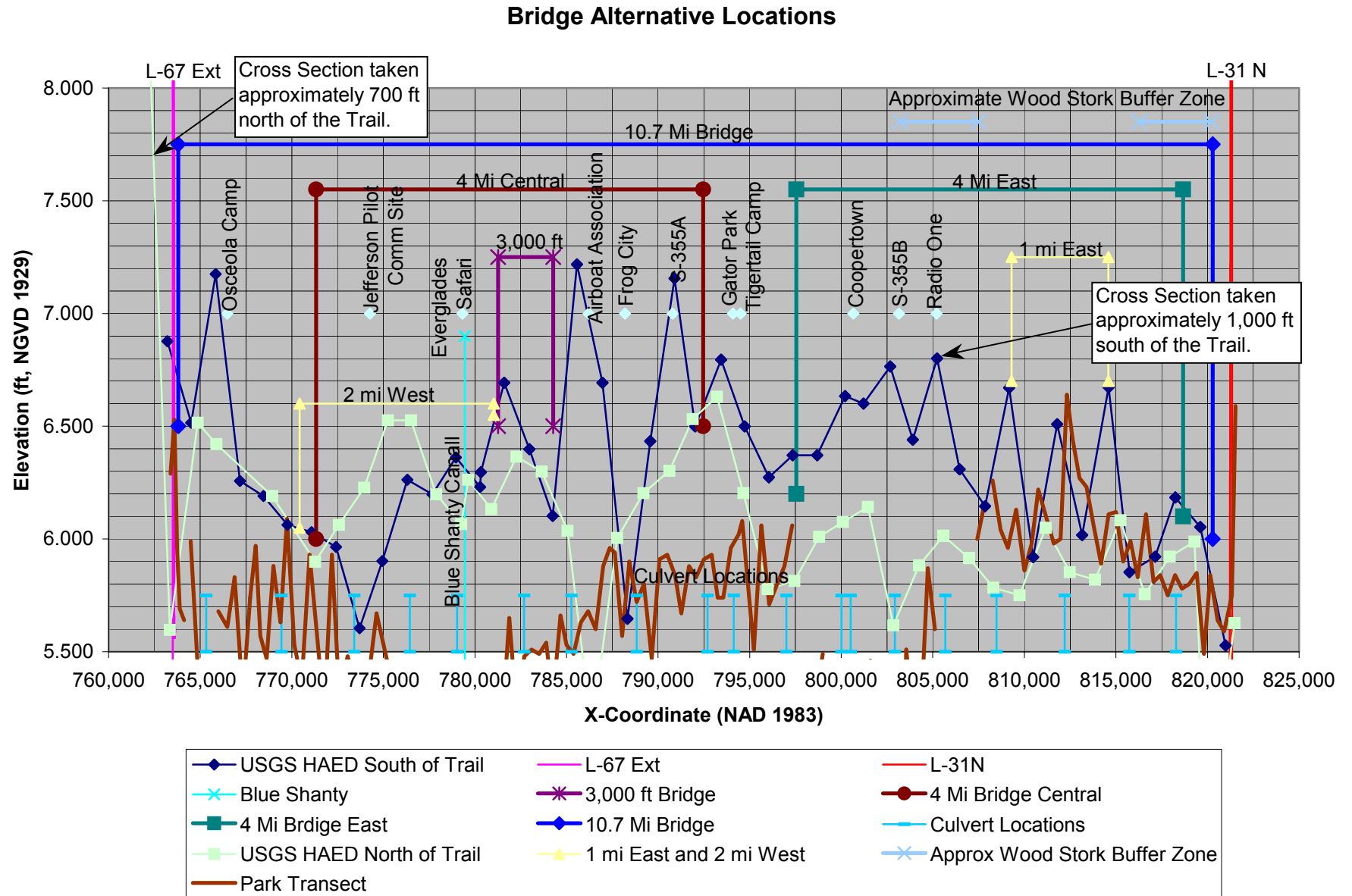


Figure 8 Bridge Locations

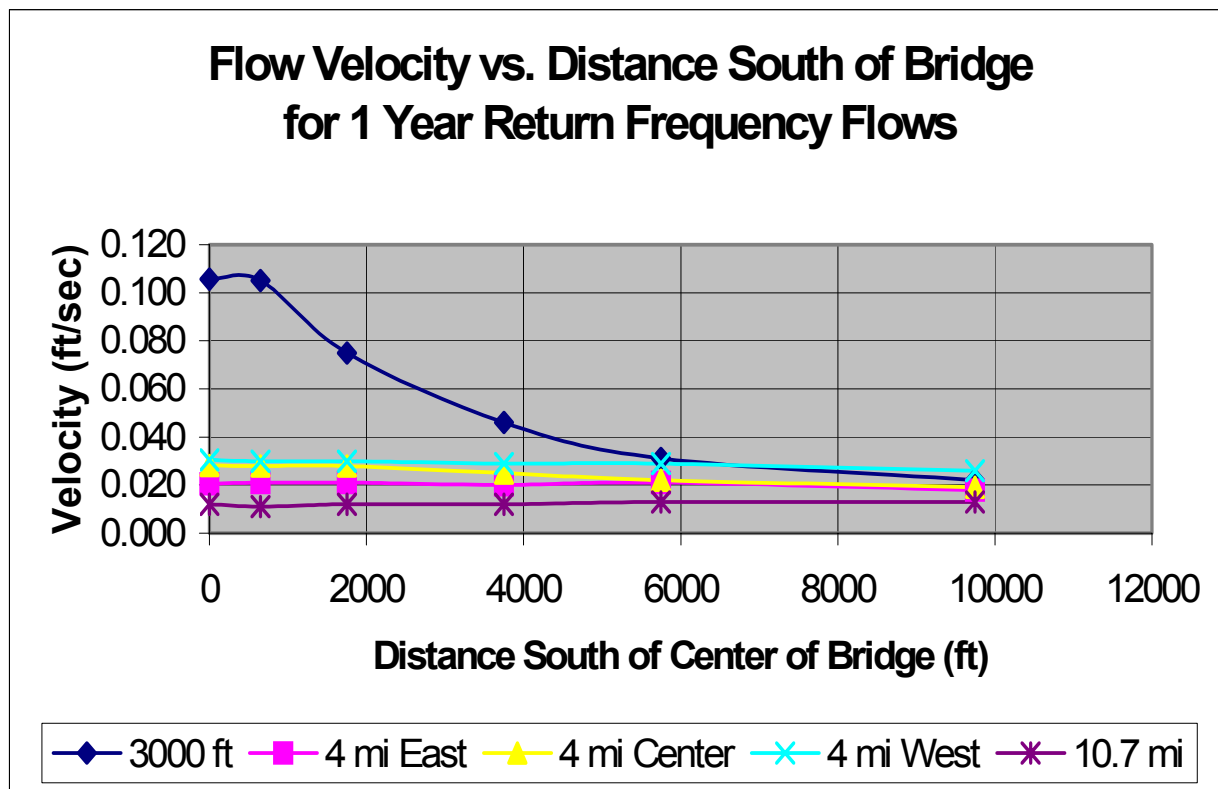


Figure 10 Flow Velocity vs. Downstream Distance 1 Year Return Frequency

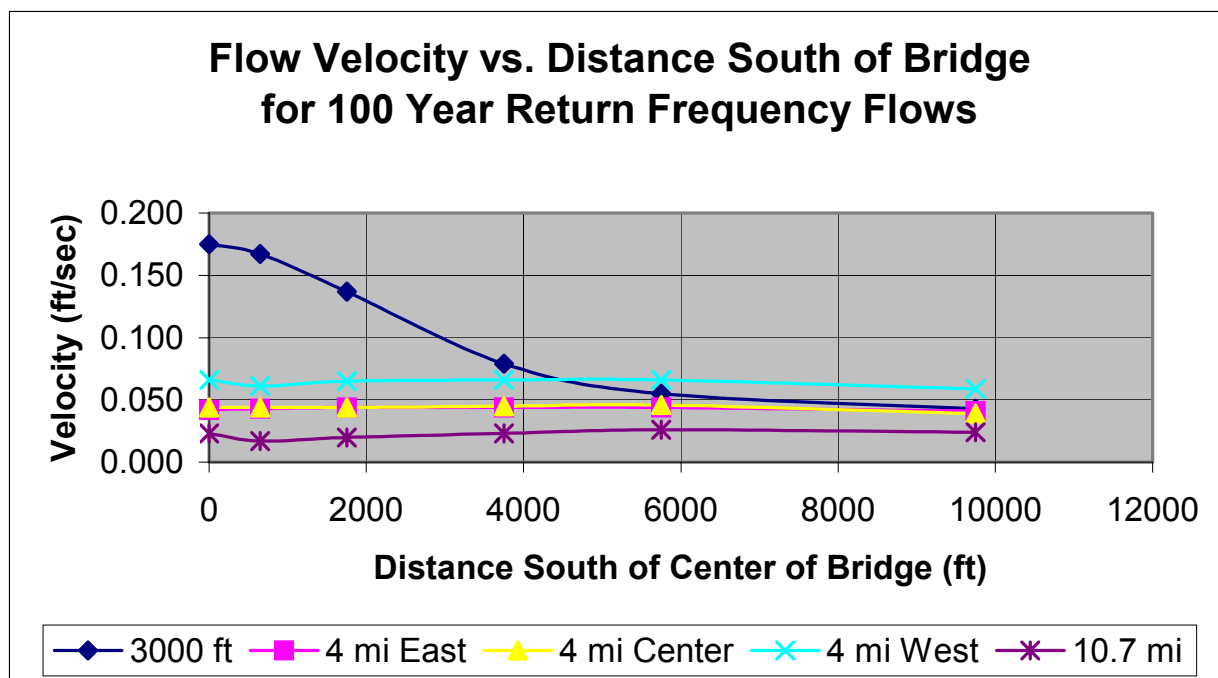


Figure 11 Flow Velocity vs. Downstream Distance 100 Year Return Frequency

Stage Differential between the L-29BC and Downstream Marsh

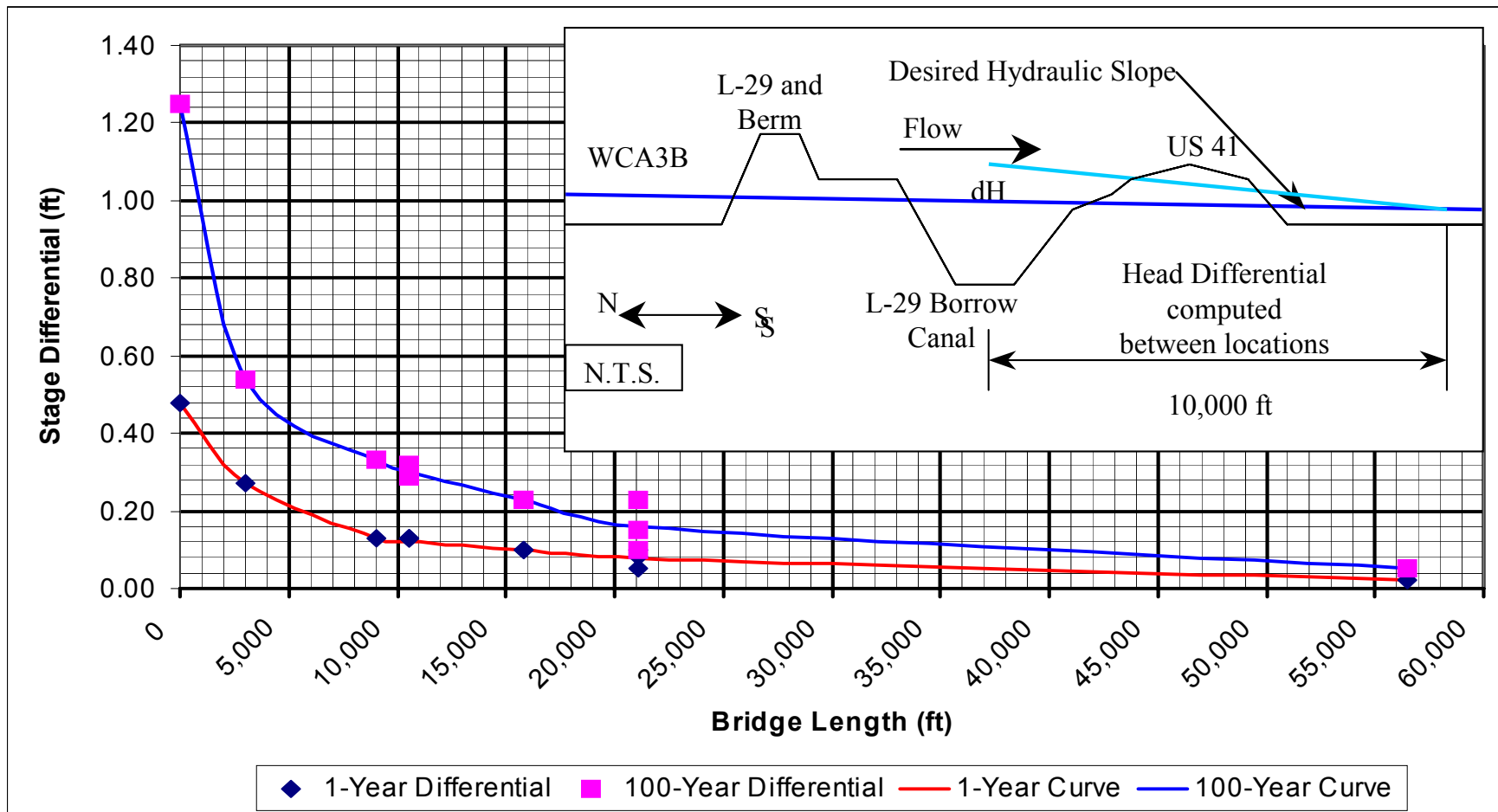


Figure 12 Stage Differential between the L-29BC and Downstream Marsh

Appendix E

TAMIAMI TRAIL MODIFICATIONS BENEFITS ANALYSIS PROCEDURES

**MWD Tamiami Trail Modification
Benefits Analysis Procedures
August 2005**

Contents	Page
Introduction	1
Screening Performance Measures	3
Description of the Performance Measures	4
Calculate Habitat Units	15
Cost Effectiveness and Incremental Cost Analysis ...	23

Introduction

Representatives from six agencies (SFWMD, ENP, USFWS, Florida FWCC, FDEP, and USACE) participated in the Tamiami Trail Modification (TTM) Benefits Workshops held 23-26 May 2005 and 6-7 July 2005 in Jacksonville, Florida. The team included engineers, hydrologists, and biologists. The TTM project area includes the 10.7-mile length of Tamiami Trail (U.S. 41) between S-333 (near L-67 Extension) and S-334 (near L-30 and L-31N) and the downstream Northeast Shark River Slough (NESS) of Everglades National Park.

The goal of the benefits analysis was to identify the hydrologic and ecological conditions that would occur with alternative lengths of conveyance (equal to bridge length) from the L-29 Borrow Canal adjacent to Tamiami Trail to Northeast Shark River Slough (NESS). These conditions would be evaluated and compared to identify quantitative benefits for each alternative.

The team used a variety of sources of information during its analysis. These included historical photos and surveys produced before Tamiami Trail was constructed in the 1920s, data on flows through Tamiami Trail bridges and culverts in the 1940s, and current topographic information. The team also reviewed computer model predictions from the Natural Systems Model (NSM) version 4.6, South Florida Water Management Model (SFWMM) runs for several of the Combined Structural and Operational Plan (CSOP) alternatives, and RMA-2 modeling of bridge lengths in Tamiami Trail. The team also borrowed from the analyses contained in the 2003 General Reevaluation Report (GRR) for Tamiami Trail Modification, the associated 2003 U.S. Fish and Wildlife Service Coordination Act Report, and a May 2005 Draft Tamiami Trail Alternative Optimization Report prepared by the Everglades National Park (ENP report).

The ENP report integrated much information and addressed more ecosystem components than the other recent reports, but it contained some assumptions that reduced its direct applicability for this Tamiami Trail RGRR, as follows.

1. The purpose of the RGRR for the Tamiami Trail component of the Modified Water Deliveries Project is to identify appropriate conveyance of water from the L-29 canal to Northeast Shark River Slough to meet the authority and objectives of the Modified Water Deliveries Project, and the necessary modifications Tamiami Trail highway to provide

this conveyance. The ENP report went further to state that this hydraulic conveyance involves the reconnection of marshes in WCA-3B to marshes in NESS. However, the Corps maintains that the purpose of the Tamiami Trail Modification component of MWD consistent with the authorization is only the conveyance of water from the L-29 canal under Tamiami Trail to NESS. Reconnection of the marshes in WCA-3B and the marshes of NESS is a very worthwhile goal but beyond the authority of the study. This reconnection is part of a proposed Decompartmentalization project of CERP.

2. The ENP report's results assume that wherever a bridge would be constructed in Tamiami Trail, the corresponding parallel section of the L-29 levee would also be removed. Removal of sections of the L-29 levee is part of the proposed Decompartmentalization (Decomp) project of CERP and not part of the MWD project. The final decision whether to remove sections of the L-29 levee will be made during the Decomp alternatives formulation and analysis process. WRDA 2000 prohibits implementing Decomp until MWD is complete.
3. The report used different SFWMM CSOP runs to represent different Tamiami Trail bridge alternatives. This is not appropriate because
 - The SFWMM does not include or simulate bridge lengths.
 - Alternative CSOP model runs include different upstream structures, operations, and flow volumes to the L-29 canal and Tamiami Trail. These differences confound a determination of whether changes are due to Tamiami Trail bridges or to one or more of the upstream differences.
4. The CSOP alternative run assigned to represent the Tamiami Trail 3,000-foot bridge alternative had lower flow volumes than the CSOP alternative assigned to represent the 4-mile alternative, thus causing the 3,000-foot bridge alternative to show fewer flow benefits. All bridge alternatives must be analyzed using the same input flows to the L-29 canal.

Even with the concerns listed above, the ENP report still contained the greatest amount of information and detailed analysis potentially applicable to the comparison of Tamiami Trail Modification alternatives. The interagency team used the report's findings as the team's baseline and focused on ways to make adjustments and correct for some of its invalid assumptions, and produce predictions that allowed valid comparisons among alternatives, while staying within the policy and legal constraints on the project.

The team went through the following sequence of steps: screen performance measures that could not be used, add additional performance measure, apply the same flows to all alternative that were used for the 4-mile and 10.7-mile alternatives, estimate values for the 4-mile east alternative by extrapolation from the values for the 4-mile central alternative, assign numerical scoring to the qualitative raw values, estimate rate of change, and estimate the acreage in NESS where the changes would occur. Four alternatives were assessed during the May workshop and five additional alternatives were assessed during the July workshop.

A subteam then worked with the scores, rates of change, and area to: normalize the scores, multiply by area to produce habitat units, factor in the rate of change, calculate the habitat unit benefit for each alternative as the difference between the with-alternative condition and future

without project condition, and calculate the average annual benefit for a 50-year period of analysis.

Screen Performance Measures

The team considered the 33 performance measures displayed in the ENP report, removing the following from further consideration in the RGRR because of the concerns discussed above.

The following 11 performance measures were removed because the differences they showed among alternatives resulted from different upstream operations of structures rather than bridge lengths.

1. Restore historic distribution of flows to ENP (% of flows west of L-67 extension)
2. Restore historic flow volumes to ENP
3. Restore historic overland flows from WCA-3A to WCA-3B
4. Restore historic overland flow volumes to NESS
5. Restore historic sheet flow conditions to NESS
6. Eliminate discontinuity in water levels above and below Tamiami Trail
7. Reduce water depths in WCA-3A
8. Reduction in Minimum flow and level (dry season depths) violations in NESS
9. Reduction in Minimum flow and level (dry season depths) violations in mid-NESS
10. Improve alligator nesting numbers and distribution
11. Reduce concentration of total phosphorus discharges to ENP from L-67A canal

The following five performance measures were removed because they depended on removing the section of the L-29 levee adjacent to a proposed bridge, rather than on bridge length

1. Reconnect historic slough habitats between WCA-3B and NESS
2. Increase physical connectivity of marshes between WCA-3B and ENP
3. Shift to open water, spikerush marsh and slough communities in NESS
4. Reduce encroachment of sawgrass and wet prairie vegetation into ENP and WCA-3B sloughs
5. Increase extent of slough vegetation communities

The following five performance measures were removed for other reasons

1. Reduce risk of ridge and tree island peat burning in Rocky Glades. This was very similar to reduce risk of ridge and tree island peat burning in NESS, which was retained
2. Four water quality performance measures: reduce injurious effect of organic forms of carbon, nitrogen, and phosphorus; increase dissolved oxygen; reduce specific conductance and sulfate concentration; increase nutrient cycling and uptake by biota. Differences in water quality were not clearly linked with bridge alternatives.

Two performance measures were revised: deep sloughs reconnected – important for both dry and wet seasons, and connectivity of ENP to flows in L-29 canal.

One new performance measure was developed for east west distribution of flows into ENP from L-29 canal.

The 13 PMs address important characteristics of ENP: hydrology, ridge & slough processes, vegetation, and wildlife. These 13 PMs reflect differences among alternative bridge lengths, and are not dependent on removing the L-29 levee or on different upstream operations.

Consistency of Models for Alternatives

The team recognized that the 3,000-foot alternative was assessed with lower flow volumes than were used for the other, larger alternatives. The team reassessed and re-estimated some performance measure values for the 3,000 alternative with the same CSOP West Bookend (WBE) alternative flows that were used for the other Tamiami Alternatives. The WBE was also used for all of the alternatives in the RMA-2 modeling of surface water velocities and flow directions.

The ENP report did not quantify the predictions for 4-mile East alternative in the same manner as for the 4-mile Central alternative or the other alternatives. The team initially assumed that many of the predictions for the central location would apply to the eastern location. The PM values were then adjusted as necessary based on known differences such as topography, vegetation, and wildlife resources and on model outputs.

Description of the Performance Measures

This section presents a brief description of each of the 13 performance measures – what they represent, how they were developed, the input information, units of measure, and the methods of calculation or estimation of values. The performance measures are placed into four groups for convenience. Values for all of the 13 performance measures are contained in **Table 1** which follows the text descriptions.

1. Restore water deliveries to ENP

- A. Average Annual Flow Volumes
- B. Proportion of area with low flow velocity (<0.1 f/s) discharges within 1 mile of Tamiami Trail
- C. Connectivity of L-29 Canal and NESS as percent of total project length
- D. Distribution of flows, east to west

2. Restore Ridge and Slough Processes

- A. Reverse filling in of sloughs
- B. Difference between average velocity in marsh and average velocity at road
- C. Flows from L-29 Canal into deep sloughs of NESS

3. Restore Vegetative Communities

- A. Shift to open water, spikerush marsh and slough communities in NESS

- B. Risk of ridge and tree island peat burning in NESS
- C. Invasion of exotic woody plant species

4. Restore Fish and Wildlife Resources

- A. Total abundance of fishes in ENP marshes
- B. Conditions for wading bird foraging and nesting
- C. Reduction in wildlife mortality

PM 1.A. Average Annual Flow Volumes

This measure presents the annual volume of water passed through the culverts and proposed bridges in the Tamiami Trail alternatives. These flows entering the L-29 canal are controlled by precipitation, upstream structures, and operation of the structures. For the Tamiami Trail Modification RGR, all alternatives were evaluated using the operations and flow volumes of the West Bookend Alternative of the Combined Structural and Operational Plan (CSOP) for the Modified Water Deliveries to Everglades National Park (MWD ENP) and the C-111 Canal projects. This volume is 683,000 acre feet per year across a transect extending across the 10 mile project area (between L-67 extension and L-31N). The estimate of flows across this transect in the Natural System Model (NSM Version 4.6) is 895,000 acre feet per year.

There are ecological benefits to delivering more water to ENP than under existing and No Action conditions. The main purpose of this performance measure is to illustrate that the alternatives can accept the largest likely flows anticipated under Modified Water Deliveries project and that the No Action alternative can not pass this volume of water. If the same 683,000 acre feet per year of water were to be delivered to L-29 canal under the No Action condition, the small conveyance provided by the existing culverts would force the stage in L-29 canal to be high enough that Tamiami Trail would be damaged. A much smaller annual volume, 493,000 acre feet per year, is all that can safely pass.

PM 1.B. Area with high flow velocity (>0.1 f/s) discharges within 1 mile of Tamiami Trail, associated with structures

Information from South Florida Water Management District's recently constructed Stormwater Treatment Areas indicated that velocities greater than about 0.1 feet per second adversely affect vegetation colonization and growth. Sediment scouring is also increased.

Flows through Tamiami Trail culverts and proposed bridges have the potential to generate velocities greater than 0.1 feet per second as the water moves from the L-29 canal past the abutments of the proposed bridge(s) or from the L-29 canal through the existing culverts.

For each alternative the area with velocities above 0.1 feet per second was computed from the RMA-2 output. This allowed for a comparison of which alternatives would produce the least amount of impacted area.

These high velocity areas were all contained within a distance of 1 mile from the road. The performance measure value was calculated with the following formula:

$$[1 - (\text{acres with velocity greater than 0.1 feet per second}) / 6,848 \text{ acres}]$$

6,848 acres is the number of acres in the 1 mile by 10.7 mile zone immediately south of Tamiami Trail. The performance measure represents the proportion of the one-mile wide zone that has velocity less than 0.1 feet per second, which are considered good velocities. The potential values range between near zero and 1.0. The target value is 1.0.

Most of the acreage measurements are between near zero and 411. The values of the performance measure for the alternatives analyzed are between 0.9 and 1.0. The impacts are expected to be intense and significant in the locations where they occur. However, the impacts occur over only a small geographic area and small proportion of the area of ENP.

No Action	3,000-ft	2 Bridge: 2-Mi W, 1-Mi E	2 Bridge: 1.3-Mi W, .7-Mi E	3 Bridge: Ea 3000-ft	1 Bridge: 2 Miles	1 Bridge: 3 Miles	4-Mile Central	4-mile East	10.7-Mile Causeway
area within 1 mile of Tamiami Trail with high velocity (<0.1 f/s), acres									
187	411	295	300	330	220	181	98	105	8
PM 1.B. Proportion of area within 1 mile of Tamiami Trail with low flow velocity (<0.1 f/s)									
0.973	0.940	0.957	0.956	0.952	0.968	0.974	0.986	0.985	0.999

PM 1.C. Connectivity of L-29 Canal and NESS, percent of total project length (Connectivity_PM.xls)

This performance measure describes the connection between the L-29 canal and NESS. If the L-29 levee is removed under a future project, then this performance measure will also represent the connection between WCA 3B and NESS. This is an evolution and improvement of a simple lineal length of opening measurement. Modeled flow patterns clearly show that water spreads out in a fantail shape at the ends of the bridge. Ecological connectivity north and south of Tamiami Trail also follows this same fan pattern shown by the hydrology.

The connection length is the length of the bridge plus a 1,000 foot width on either side of the bridge. This connected length is then divided by the total width of eastern Shark Slough (from L-67 Extension to the L-31N levee) and expressed as a percentage. The calculations account for and prevent overlapping (double counting) and do not add “extra” connectivity by extending beyond the eastern and western limits of the project area. Movements of water and individuals are not limited to a straight line north-south path.

A 100% value indicates full connectivity and is the target.

Alternative	Connectivity PM	Length of Opening Ratio
10.1 M	100%	93%
4M Center	39%	36%
4M East	39%	36%
3M Center	30%	27%
2MC & 1ME	34%	27%
2M Center	21%	18%
1.3MC & 0.7ME	25%	18%
2M Center	21%	18%
3 3,000 feet	25%	15%
3,000 feet	8%	5%

PM 1.D. Distribution of flows, east to west

(Flow_Distribution_PM.xls)

Under pre-development conditions, there were no barriers to flow such as Tamiami Trail. Water flowed across a widely distributed, broad front. Water flowing southward was not directed to one or a small number of channels or openings. This Distribution of Flows, East to West performance measure describes how well the water flowing south from L-29 canal under Tamiami Trail is distributed in the east to west direction relative to the distribution that would occur if the highway was not in place.

This PM uses the flows from the RMA-2 modeling and then tracks the percent deviation from the skyway bridge flows using approximately 11 one mile wide sections. This performance measure gauges how well the bridge length and location(s) in combination with the culverts match the more natural distributions as represented by the full bridge length alternative.

The method calculates the percent deviation for each approximately one mile wide transect and then calculates a flow weighted (using the 10-mile skyway flows) total deviation. This deviation expressed in percent is subtracted from 100% to express how well the alternatives distribution matches the skyway distribution. Higher values represent a more restored condition.

A 100% value indicates flow distribution completely consistent with the 10-mile skyway bridge.

PM 2.A. Reverse filling-in of sloughs

This PM is not directly proportional to bridge length, but is related to the alignment of the bridge with existing degraded sloughs south of Tamiami Trail as revealed by the USGS High Accuracy Elevation Data (HAED). Siting a bridge directly upstream of a degraded slough would maximize the potential for storm flow velocities to scour out sediments that have been accumulating in the sloughs since Tamiami Trail was constructed. The length of the bridge has relevance only to the extent that it can encompass more sloughs within its flow cross-section. The alternatives were scored on a scale of 0-7 as follows.

No Action = 0: The assumption is that the culverts would be kept at the FDOT max stage limitation of 7.5 feet. Therefore, flows through the culverts would be a continuation of existing conditions that are resulting in slough degradation.

3000-foot = 1: Minimally better than culverts - potential flow into only one slough.

10.7-mile = 7: This represents maximum potential for restoration of sloughs.

4-mile Central = 5: Would direct flows into five sloughs.

4-mile East = 5: Would direct flows into six sloughs, but they are more seriously degraded with less potential for restoration.

3-mile West = 4: Would direct flows into three sloughs, including the deepest.

2 mi West + 1 mi East = 4: Would direct flows into four sloughs, but the ones on the east are less susceptible to restoration.

2-mile West = 3: Would direct flows into two sloughs.

1.3 mi West + 0.7 mi East = 3: Would direct flows into two sloughs.

3 x 3000-foot = 2: Would direct flows into three sloughs, but only the westernmost one has a high potential for restoration.

PM 2.B. Difference between average velocity in marsh and average velocity at road

This performance measure describes how closely the water velocities near the road match the marsh velocity at a distance approximately 6,000 feet downstream of the road. The ideal situation is for the bridge to have marsh like velocities from the bridge south. The higher velocities that the shorter bridge produces are extremely destructive to the ridge and slough environment of the Everglades immediately south of the Tamiami Trail.

The velocity at the center of the bridge for each alternative was compared against each alternative for a distance of approximately 6,000 feet downstream of the road. This analysis looked at the 1- and 100-year return frequency discharges. The data for this performance measure - estimated velocities at the road for each alternative - are derived from RMA-2 model

runs. The average velocity in the marsh that is used in the calculations for all alternatives is 0.024 feet per second.

Ratio: (average velocity in marsh) / (average velocity at road in center of bridge opening)

High velocities near the road result in low values for the PM. For example, a ratio of 0.5 would represent a velocity at the road that is 2x the velocity in the marsh, and a ratio of 0.1 would represent a velocity at the road that is 10x the velocity in the marsh. Velocities near the road that are close to the velocities in the marsh have a high value approaching 1.0. Values range from zero to 1.0. The target for this performance measure is 1.0.

PM 2.C. Flows from L-29 Canal into Deep Sloughs of NESS

While the existing culverts provide a hydraulic connection to the deeper sloughs existing within Northeastern Shark Slough (NESS) the capacity is not commensurate with amount of flow expected in these deeper sloughs during both high and low flow conditions. Preferential flow through these deeper sloughs is even more pronounced during drier times.

As can be seen in Figure 1, the eastern portion of Shark Slough (from the L-67 extension to the L-31N levee) varies in elevation from about 5.6 feet NGVD to 7.2 feet NGVD. Without the obstruction of Tamiami Trail the preferential flow path from this varying elevation would be in the deeper sloughs. Figure 1 shows the relative marsh capacity for a stage of 7.5 feet NGVD, which represents a typical transitional condition when the highest areas are only slightly inundated. The distribution of flow within northeast Shark Slough will become more uniformly distributed (from West to East) as depth increases and the relative depth differences reduce. The 7.5 feet NGVD stage is within two tenths of a foot the median value for the No Action and Alternatives 1 through 4 of the Combined Structural and Operational Plan (CSOP) for the Modified Water Deliveries to Everglades National Park (MWD ENP) and the C-111 Canal projects.

Average and High Flow Conditions

The stages in northeast Shark Slough range from about 4 feet NGVD (about 2 feet below ground surface) to 9 feet NGVD with a median stage of about 7.5 feet NGVD. As can be seen in Figure 1, the stage of 7.5 feet NGVD results in an average depth of about 1.1 feet with a maximum depth of about 1.9 feet and a minimum depth of about 0.3 feet

The increased connection provided by the bridge aligned with deeper portions of northeast Shark Slough facilitates increased flow where it should occur preferentially. As can be seen in Figure 1, with the water level less than 0.5 above the ridges most of the flow occurs in the deeper sloughs. It is important for water to be rapidly delivered to these deeper sloughs, commensurate with this capacity, during wet periods to produce higher velocities desirable for the

redevelopment and maintenance of open water vegetation in these sloughs. This assessment assumes that sheet flow is based on the following equations

Manning Equation; $Q = (u/n) A R_h^{(2/3)} (h_f / L)^{(1/2)}$
A depth dependent Manning n ($n = \sim d^{-0.77}$)

Where:

A = Cross Section Flow Area = $W * d$
W = Flow Width
d = Flow Depth
P = Wetted Perimeter
R = Hydraulic Radium = $A/P = (W * d) / W \sim d$

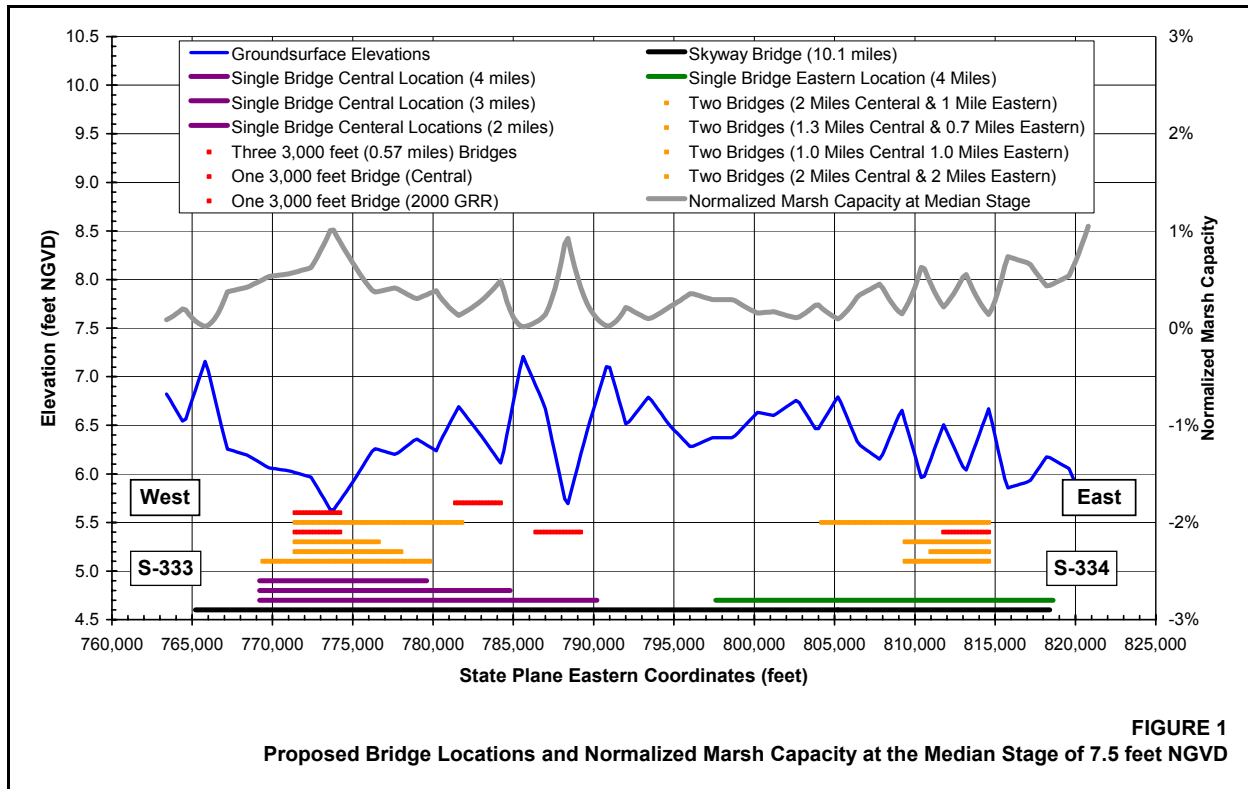
Dry Conditions

During dry periods these deeper sloughs will have meaningfully deeper levels. The importance of these connections during drier periods is increased by the fact that both the existing condition and the expected range of the “with project” conditions (Tamiami Trail Bridge in conjunction with CSOP Operations) are drier than the desired conditions as represented by the Natural System Model (NSM). Specifically, NSM Version 4.6 predicts that the water levels would be at or below ground surface for approximately 2% of the time whereas as the existing conditions (ALT7R5) and alternatives (1 through 4) range from 8% to 11% of the time. The CERP reduces these dry conditions to 4% of the time. The increased connection that a bridge provides over culverts in terms of capacity and connectivity (sheet flow with low velocity versus flow through culverts) is expected, for the same water availability, to have the following benefits:

- Better distribution of the water; high water levels with more natural recession rates and less abnormal dry out as the limited water available can reach these sloughs.
- Facilitates the movement of fish into the L-29 canal through the deepest portions of Northeastern Shark Slough during dry outs which allows for rapid repopulation of these sloughs.
- Reduces unnatural predation around the culverts due to their limited area.

Evaluation Procedure

The benefits of different bridge lengths and locations were assessed considering each bridge location. A representative “marsh capacity” was estimated on 200 feet wide intervals using the USGS helicopter ground elevations and Manning’s “n” based flow equation used in the South Florid Water Management Model (SFWMM). The location of each bridge is then used to calculate the marsh capacity directly connected by a bridge opening. This marsh capacity for the bridge is then divided by the marsh capacity of the approximately 11 mile wide northeast Shark Slough from the L-67 Extension to the L-31N levee (NAD83 horizontal coordinates from 763,500 to 821,250) and expressed as percentage. The full bridge option with 0.3 mile long ramps at each end (ending 0.3 miles West of S-334) had a total bridge length of 10.1 miles and encompassed 91% of the entire marsh capacity.



(from "Identification_of_Major_Slough.NEW.20050801_baf.xls")

PM 3.A. Shift to open water, spikerush marsh, and slough communities in NESRS

NESRS historically was part of the ridge and slough ("corrugated") Everglades landscape. Over the past 40 years of hydrologic isolation from the ecosystem to the north, it has largely converted to a drier community of mixed sawgrass. This PM evaluates the potential for alternatives to restore the historic landscape. It is driven by the depth and duration of flooding downstream of the bridges. The remnant sloughs on the eastern side of the project area are more degraded and therefore would be more difficult to be restored. There is also a greater number of remnant sloughs on the western side and there is historic information that pre-development flows through them were proportionately greater than would be indicated by their combined cross-section. Consequently, alternatives that are focused on flowing water through the west side are generally scored higher. Direct flooding of sloughs (immediately downstream of a bridge) is considered most beneficial because lateral flooding of adjacent sloughs will become truncated as seasonal flows diminish and interspersed ridges **isolate** southward flows. The bridge alternatives were scored on a scale of 0-7 as follows.

No Action = 0: The assumption is that the culverts would be kept at the FDOT max stage limitation of 7.5 feet. Therefore, flows through the culverts would be a continuation of the existing conditions that are degrading the sloughs.

3000-foot Bridge = 1: Minimally better than culverts – relatively narrow flow path directly floods only one slough.

10.7-mile = 7: This represents maximum potential for restoration of sloughs because it directly floods all the remnant sloughs.

4-mile Central = 6: This directly floods all the important remnant sloughs on the western side, but not directly those on the east.

4-mile East = 4: This directly floods all the eastern remnant sloughs, but was down-rated because those are less susceptible to restoration.

3-mile West = 5: This directly floods fewer sloughs, so was down-rated from the 4-mile Central.

2 mi West + 1 mi. East = 5: This floods fewer sloughs on the west than the 3-mile, but picks up some on the east so it was scored the same.

2-mile West = 4: This was down-rated from the 3-mile because it directly floods fewer sloughs.

1.3 mi West + 0.7 mi East = 3: This directly floods fewer sloughs on the west and the east so was down-rated two points from the 2+1 bridge.

3 x 3000-foot = 4: Each of these bridges was positioned directly in front of a slough, so the three slough flooding represents an up-rating from the 1.3+0.7 bridge.

PM 3.B. Risk of ridge and tree island peat burning in NESRS

This PM is dependent on hydroperiod and whether the bridge delivers enough water to keep peat soils hydrated enough to minimize fire risk.

No Action = 2: The assumption is that the culverts would be kept at the FDOT max stage limitation of 7.5 feet. Therefore, flows through the culverts would be limited, but would provide some hydration of soils to limit burning.

3000-foot Bridge = 5: This minimal hydraulic bridge length would not curtail flows, but its narrow span would truncate lateral spread. This would cause earlier soil dry-outs at the eastern side of the project, so it was down-rated from the other bridge scores.

10.7-mile = 7: This represents the maximum potential to keep soils hydrated over the full cross section.

4-mile Central = 6: An intermediate length between 3000 and 10.7 was given the intermediate score.

4-mile East = 6: An intermediate length between 3000 and 10.7 was given the intermediate score.

3-mile West = 6: An intermediate length between 3000 and 10.7 was given the intermediate score.

2 mi West + 1 mi. East = 6: An intermediate length between 3000 and 10.7 was given the intermediate score.

2-mile West = 6: An intermediate length between 3000 and 10.7 was given the intermediate score.

1.3 mi West + 0.7 mi East = 6: An intermediate length between 3000 and 10.7 was given the intermediate score.

3 x 3000-foot = 6: An intermediate length between 3000 and 10.7 was given the intermediate score.

PM 3.C. Invasion of exotic woody plant species

This PM is dependent on two factors:

- 1) The alternative's capacity to keep the sloughs inundated to prevent exotic seedlings from invading.
- 2) The bridges length- the longer the bridge the greater number of exotic species that will be eliminated as the road embankment is removed for the bridge. This considered less important than the inundation factor.

No Action = 2: The assumption is that the culverts would be kept at the FDOT max stage limitation of 7.5 feet, but flows through the culverts would still provide some capacity to keep the area inundated.

3000-foot Bridge = 4:

10.7-mile = 7: This would provide maximum potential for exotic control by removing all exotics along the highway and maximum inundation.

4-mile Central = 6: This was considered equivalent to the 10.7 mile for inundation, but was down-graded one point for shorter length.

4-mile East = 6: This was considered equivalent to the 10.7 mile for inundation, but was down-graded one point for shorter length.

3-mile West = 5: This was down-graded one point from the 4-mile because of shorter length and slightly poorer inundation potential.

2 mi West + 1 mi. East = 5: This was considered equivalent to the 3-mile.

2-mile West = 4: This was down-graded one point from the 3-mile because of shorter length and slightly poorer inundation potential.

1.3 mi West + 0.7 mi East = 4: This was considered equivalent to the 2-mile single span.

3 x 3000-foot = 4: This was considered equivalent to the 2-mile single span.

PM 4.A. Total abundance of fishes in ENP marshes

The PM is defined as being dependent on:

- 1) Lateral connection of sloughs through overflow from deeper sloughs improves fish access to micro-topographic relief refugia during dry-downs and increases hydroperiod within adjacent sloughs.
- 2) Longer bridge length increases pathways for fish dispersion and movement by improving and extending escape routes to L-29 Canal habitat during the dry season.

No Action = 0: The assumption is that the culverts would be kept at the FDOT max stage limitation of 7.5 feet. Therefore, flows through the culverts would be too small to reconnect any sloughs.

3000-foot Bridge = 1: Minimal benefit since it is not sited over a major slough.

10.7-mile = 7: This distributes water and biota laterally to the greatest extent.

4-mile Central = 5: This is down-rated from the 10.7 because fewer sloughs are spanned, resulting in less potential for lateral overflow to facilitate fish movement in response to drying conditions.

4-mile East = 5: This is considered equivalent to 4-mile West.

3-mile West = 4: This was down-rated from the 4-mile because shorter length spans fewer sloughs.

2 mi West + 1 mi. East = 4: This is considered equivalent to 3-mile West.

2-mile West = 3: This was down-rated from the 3-mile because shorter length spans fewer sloughs.

1.3 mi West + 0.7 mi East = 3: This is considered equivalent to 2-mile West.

3 x 3000-foot = 3: This is considered equivalent to 2-mile West.

PM 4.B. Conditions for wading bird foraging and nesting

This PM is based on the potential for restoring hydropatterns in NESRS to increase abundance and availability of forage fish that wading birds depend on for nesting success. Natural hydropatterns increase fish abundance and availability to wading birds during the crucial nesting period. Bridge alternatives on the east side of NESRS have reduced potential benefits for foraging wading birds because of limited microtopography leaving forage fish stranded over a shortened time period. Water delivered to western side is more beneficial to birds because water flows to the east side will dry out quicker due to degraded (shallower) sloughs and greater seepage. Deeper sloughs are preferred over shallower sloughs given that during the dry season the deeper sloughs are more likely to have continuous flows and during the wet season have overland flows. Bridges immediately adjacent to existing bird rookeries are less beneficial than bridge locations that include a buffer distance.

No Action = 0: The assumption is that the culverts would be kept at the FDOT max stage limitation of 7.5 feet. Therefore, flows through the culverts would be too small to see any beneficial effect.

3000-foot Bridge = 1: Minimal benefit since it is not sited over a major slough that would contribute to restored hydropatterns.

10.7-mile = 7: Allows for maximum potential restoration of hydropatterns.

4-mile Central = 5: Down-rated from 10.7 because shorter length has less potential for redistribution of flows restoring hydropatterns.

4-mile East = 4: Down-rated from 4-mile West because flows to the east are less beneficial due to the existing slough degradation results in shorter hydroperiods and earlier dry-out and because the bridge would be immediately adjacent to existing bird rookeries.

3-mile West = 4: Considered equivalent to 4-mile East because shorter length is offset by presence of deeper sloughs.

2 mi West + 1 mi. East = 4: Considered equivalent to 3-mile by virtue of the same overall span length.

2-mile West = 3: Down-rated from 3-mile because shorter length provides less potential to restore hydropatterns and no distribution of benefits to the east.

1.3 mi West + 0.7 mi East = 3: Scored equivalent to 2-mile by virtue of the same overall span length and distribution of benefits to the east.

3 x 3000-foot = 3: Considered equivalent to 2-mile by virtue of nearly the same overall span length.

PM 4.C. Reduction in wildlife mortality

This performance measure is based on average mortality data from USFWS for Tamiami Trail. The data describe an average of 261 deaths per mile of road per year and assumes that this rate applies to the entire 10 mile long project area.

The deaths of small animals from collision with automobiles would continue to occur on the sections of Tamiami Trail that would still be connected to the adjacent marsh and canal. The deaths would not occur on the bridged sections of Tamiami Trail because there would be no connection between the road surface and the marsh and canal habitat of the animals. The animals would not easily reach the road surface in these sections and then be at risk of being hit.

The performance measure presents the numbers of deaths that would be avoided because of the presence of the bridge(s). It is calculated by multiplying 261 deaths per mile per year by the total length of the bridge(s) in miles. A short bridge would only result in a small reduction in mortality while a bridge that spans the entire project area would produce the maximum value of 2,737 deaths per year avoided.

Performance Measures Values

The raw values for all of the performance measures described in the previous section are presented in **Table 1**. The values for the performances measures were in many different units. Units included percent, feet, acres, acre-feet, feet per second, and scores of 0-7.

Calculating Habitat Units and Benefits

Although the Tamiami Trail PDT evaluated many performance measures to ascertain how well each of the alternative plans performed on various criteria indicative of ecosystem restoration, (e.g., average annual flow volumes, shift to open water, abundance of fishes in ENP marshes, and reverse filling in of sloughs), habitat units derived from the performance measures were selected by the PDT as the metric that best integrated information regarding the quality and quantity of improved hydrologic and ecologic function within the study area.

Sometimes it is difficult to summarize the results when the analyses are performed separately for distinct performance indicators. This phenomenon often occurs simply because different

management measures or alternative plans “do” different things, provide different types of output, and provide benefits to different biological communities. This is true for the Tamiami Trail features and alternatives, in which certain performance measures quantify output in flows and hydrologic modeling output, and other performance measures examine ecological responses in a qualitative manner.

In order to estimate total benefits from the various alternatives, it is desirable to be able to perform CE/ICA on a metric that combines all performance measures output. Simply adding the performance measure output would be problematic, because the PM’s operate at vastly different scales (i.e., two PM’s only apply to a small geographic area), ecosystem responses to alternatives occur gradually through time, and the performance measures resources are represented in very different metrics (e.g., feet, acres, acre-feet, feet per second, percent, and qualitative measures). All three of these issues are addressed in the following description of the calculation of benefits.

The changes produced by each alternative were assessed over the same **acreage** of Northeast Shark River Slough, even though not all of the individual performance measures affected the same entire acreage. The area for analysis and comparison is defined by L-67 Extension on the west, Tamiami Trail on the north, and the L-31N and the 8.5 Square Mile Area (SMA) on the east. There is no firmly defined boundary on the south; the differences between alternatives and the without project condition gradually decrease as one moves south. For this study, the southern limit is defined by the team as an east-west line connecting the end of the L-67 Extension to 8.5 SMA. The total area is 63,195 acres. Eleven of the 13 performance measures apply to the entire 63,195 acres. Two of the 13 performance measures, 1.B and 2.B, only apply to the northernmost 1-mile wide by 10.7-mile long strip of land nearest Tamiami Trail, which totals 6,848 acres.

The team prepared a simple description of the changes in ecosystem conditions through **time** in response to the alternatives. The performance measures values and scores represent the ultimate, or end-point, of changes due to the alternatives, and the team recognized that the restoration of the entire area would not occur immediately after construction is complete. For the alternatives, the team estimated that 30 percent of the end-point would be achieved in the first year. Most of this represents the hydrological changes such as depth, velocity, and hydroperiod. The team further estimated that an additional six years, for a total of seven years, for the full extent of changes to occur. The herbaceous vegetation may take this long to fully respond to the hydrological changes. Fish and wildlife populations require a few seasons to respond to the changed hydrology and vegetation. Although not fully predictable, there is a good likelihood that a wet or dry year will occur during this period, further emphasizing the importance of incorporating events such as scouring some of the sediments and vegetation that have accumulated in the sloughs during high water events or connecting deep sloughs to the L-29 canal to maintain water during the lowest flow periods. The without project condition is proposed to remain the same throughout the period of analysis, the same as existing conditions. The period of analysis is 50 years, from 2010 to 2060.

The different **metrics** made it necessary to normalize the different PM’s into a 0-1 index. The normalization method used was “percent of maximum”, in which the maximum output achieved in each category by any of the alternatives was assigned a “1”, and the output values for other

alternatives for that same resource category were scaled as a percentage of that maximum (between 0 and 1). An index value of 1 would thus be assigned to an alternative that provides the maximum output value for the habitat unit categories, while a value of 0.5 would equate to the output value for an alternative that only provides 50% of the maximum output provided by the “largest” alternative (a hypothetical “largest” alternative in terms of delivering the maximum output of every habitat type). While other normalization techniques exist (e.g., percent of range, percent of total, unit vector), the percent of maximum is the most widely used technique and is usually the default method. Thus, a combined, normalized metric was calculated to perform CE/ICA on all outputs provided by the Tamiami Trail alternatives.

As an example of normalization, consider Performance Measure 1.A, average annual flow volumes. The goal is the NSM flow volume of 895 (ac-ft x 1,000), the flow that was established for each alternative was 683 (ac-ft x 1,000). The goal represents the maximum desired condition regarding the metric the PM measured. The normalization score for these alternatives resulted from dividing the goal by the alternative score and coming up with an index score. For the PM, the index score was the same for all alternatives and was .763. The no action condition for the PM was 493 (ac-ft x 1,000), and the index for the no action condition was calculated as .551. The basic methodology behind these calculations were held constant for each PM, with minor revisions to PM 1.B in which the lower the score the better had to be inversed, and PM 2.B where the PM was already an index reflecting a ratio. Index scores were calculated for all alternatives and for the no action condition. **Table 2** includes a list of the normalized value for each PM and alternative.

Habitat units were calculated by multiplying the indices by the acreages that were impacted by the PM’s (PM 1.B and 2.B affected 6,848 acres, while the rest of the PM’s affected the full 63,195 acres). The average annual calculation also takes into account that achievement of full performance is estimated to take seven years because the plant and animal resources only gradually respond to the physical changes generated by the alternatives. The average annual lift for each PM was calculated by subtracting the average annual habitat units for the no action plan from the average annual habitat units for each alternative. **Table 3** includes average annual Habitat Unit lift for each PM.

Each of the PM’s were determined to be of equal importance, and were therefore all given a weight of “1” to be used to combine the habitat units associated with each PM. Since all of the habitat units occupied the same geographic area, an average of all the PM’s was warranted. The averaging of the habitat units was a two-part process. It was first necessary to find the total habitat units of the upper section of the study area, and then the total habitat units of the lower section of the study area, and add these together to determine the total (HU) lift for the entire study area. This was necessary because two PM’s only affect the upper 6,848 acres of the study area, while the rest of the PM’s affected the entire study area. This 6,848 acre section accounts for 10.84% of the entire study area, so the process involved multiplying each of the 11 PM’s that impacted the entire study area by .1084 and adding these habitat units to the two that impacted just the 6,848 acres. This total was then divided by 13 (due to 13 total PM’s) to arrive at an average annual habitat unit lift for the upper section. The lower section only pertained to 11 PM’s. These 11 PM’s were multiplied by 89.16% to determine the habitat units that are associated with the lower section. Each of these figures were then added and the total was

divided by 11 to arrive at the average annual lift of the lower section. The lower section and the upper sections average annual lift were then added to determine the total lift for the study area. This procedure ensured that no PM was double counted and the PM's that only affected the upper section of the study area were adjusted to reflect the lesser impact. **Table 4** includes the calculations for the upper and lower sections and the total habitat unit lift, or benefit, for each alternative.

Table 1: Raw Values for Performance Measures

	No Action	3,000-ft	2 Bridge: 2-Mi W, 1-Mi E	2 Bridge: 1.3-Mi W, .7-Mi E	3 Bridge: Ea 3000- ft	1 Bridge: 2 Miles	1 Bridge: 3 Miles	4-Mile Central	4-mile East	10.7-Mile Causeway
2. Restoration										
1 <u>Restore water deliveries to ENP</u>										
A. Flow Volumes, x1000 acre ft	493	683	683	683	683	683	683	683	683	683
B. Proportion of area within 1 mile of Tamiami Trail with low velocity (<0.1 f/s)	0.973	0.940	0.957	0.956	0.956	0.952	0.968	0.986	0.985	0.999
C. Connectivity of L-29 Canal and NESS, percent of total length, %	0	8	34	25	25	21	30	39	39	100
D. Distribution of flows, east to west, %	0	57	59	61	70	51	57	46	23	100
2 <u>Restore Ridge and Slough Processes</u>										
A. Reverse filling in of sloughs	0	1	4	3	2	3	4	5	5	7
B. Difference between average velocity in marsh and average velocity at road, ratio	0.014	0.137	0.455	0.345	0.238	0.455	0.500	0.556	0.556	1.000
C. Enhance flows from L-29 Canal into deep sloughs of NESS, %	0	11	39	27	23	30	37	45	34	91
3 <u>Restore Vegetative Communities</u>										
A. Shift to open water, spikerush marsh and slough communities in NESS	0	1	5	3	4	4	5	6	4	7
B. Risk of ridge and tree island peat burning in NESS	2	5	6	6	6	6	6	6	6	7
C. Invasion of exotic woody plant species	2	4	5	4	4	4	5	6	6	7
4 <u>Restore Fish and Wildlife Resources</u>										
A. Abundance of fishes in ENP marshes	0	1	4	3	3	3	4	5	5	7
B. Conditions for wading bird foraging and nesting	0	1	4	3	3	3	4	5	4	7
C. Reduction in wildlife mortality, #/year	0	148	783	522	455	522	783	1044	1044	2737

Table 2: Normalized Indices for Performance Measures

2. Restoration	No Action	3,000-ft	2 Bridge: 2-Mi W, 1-Mi E	2 Bridge: 1.3-Mi W, .7-Mi E	3 Bridge: Ea 3000-ft	1 Bridge: 2 Miles	1 Bridge: 3 Miles	4-Mile Central	4-mile East	10.7-Mile Causeway
1 <u>Restore water deliveries to ENP</u>										
A. Flow Volumes	0.551	0.763	0.763	0.763	0.763	0.763	0.763	0.763	0.763	0.763
B. Proportion of area within 1 mile of Tamiami Trail with low velocity (<0.1 f/s)	0.973	0.940	0.957	0.956	0.952	0.968	0.974	0.986	0.985	0.999
C. Connectivity of L-29 Canal and NESS, percent of total length	0.000	0.080	0.340	0.250	0.250	0.210	0.300	0.390	0.390	1
D. Distribution of flows, east to west	0.000	0.570	0.590	0.610	0.700	0.510	0.570	0.460	0.230	1
2 <u>Restore Ridge and Slough Processes</u>										
A. Reverse filling in of sloughs	0.000	0.143	0.571	0.429	0.286	0.429	0.571	0.714	0.714	1
B. Difference between average velocity in marsh and average velocity at road	0.014	0.137	0.455	0.345	0.238	0.455	0.500	0.556	0.556	1
C. Enhance flows from L-29 Canal into deep sloughs of NESS	0.000	0.110	0.390	0.270	0.230	0.300	0.370	0.450	0.340	0.91
3 <u>Restore Vegetative Communities</u>										
A. Shift to open water, spikerush marsh and slough communities in NESS	0.000	0.143	0.714	0.429	0.571	0.571	0.714	0.857	0.571	1
B. Risk of ridge and tree island peat burning in NESS	0.286	0.714	0.857	0.857	0.857	0.857	0.857	0.857	0.857	1
C. Invasion of exotic woody plant species	0.286	0.571	0.714	0.571	0.571	0.571	0.714	0.857	0.857	1
4 <u>Restore Fish and Wildlife Resources</u>										
A. Abundance of fishes in ENP marshes	0.000	0.143	0.571	0.429	0.429	0.429	0.571	0.714	0.714	1
B. Conditions for wading bird foraging and nesting	0.000	0.143	0.571	0.429	0.429	0.429	0.571	0.714	0.571	1
C. Reduction in wildlife mortality	0.000	0.054	0.286	0.191	0.163	0.191	0.286	0.381	0.381	1

TABLE 3: AVERAGE ANNUAL HABITAT UNIT LIFT PER PERFORMANCE MEASURE

	Acres Impacted	3,000-ft	2 Bridge: 2-Mi W, 1-Mi E	2 Bridge: 1.3-Mi W, .7-Mi E	3 Bridge: Ea 3000-ft	1 Bridge: 2 Miles	1 Bridge: 3 Miles	4-Mile Central	4-mile East	10.7-Mile Causeway
<u>Restore water deliveries to ENP</u>										
A. Flow Volumes	63,195	12,745	12,745	12,745	12,745	12,745	12,745	12,745	12,745	12,745
B. Proportion of area within 1 mile of Tamiami Trail with low flow velocity (<0.1 f/s)	6,848	(213)	(103)	(107)	(136)	(31)	6	85	78	170
C. Connectivity of L-29 Canal and NESS, percent of total length	63,195	4,803	20,412	15,009	15,009	12,607	18,011	23,414	23,414	60,035
D. Distribution of flows, east to west	63,195	34,220	35,421	36,622	42,025	30,618	34,220	27,616	13,808	60,035
<u>Restore Ridge and Slough Processes</u>										
A. Reverse filling in of sloughs	63,195	8,576	34,306	25,729	17,153	25,729	34,306	42,882	42,882	60,035
B. Difference between average velocity in marsh and average velocity at road	6,848	798	2,864	2,150	1,456	2,864	3,160	3,521	3,521	6,413
C. Enhance flows from L-29 Canal into deep sloughs of NESS	63,195	6,604	23,414	16,210	13,808	18,011	22,213	27,016	20,412	54,632
<u>Restore Vegetative Communities</u>										
A. Shift to open water, spikerush marsh and slough communities in NESS	63,195	8,576	42,882	25,729	34,306	34,306	42,882	51,459	34,306	60,035
B. Risk of ridge and tree island peat burning in NESS	63,195	25,729	34,306	34,306	34,306	34,306	34,306	34,306	34,306	42,882
C. Invasion of exotic woody plant species	63,195	17,153	25,729	17,153	17,153	17,153	25,729	34,306	34,306	42,882
<u>Restore Fish and Wildlife Resources</u>										
A. Total abundance of fishes in ENP marshes	63,195	8,576	34,306	25,729	25,729	25,729	34,306	42,882	42,882	60,035

B. Conditions for wading bird foraging and nesting	63,195	8,576	34,306	25,729	25,729	25,729	34,306	42,882	34,306	60,035
C. Reduction in wildlife mortality	63,195	3,246	17,175	11,450	9,761	11,450	17,175	22,900	22,900	60,035

TABLE 4: HABIT UNIT LIFT FOR UPPER AND LOWER SECTIONS AND TOTAL HABITAT UNIT LIFT PER ALTERNATIVE

	3,000-ft	2 Bridge: 2-Mi W, 1-Mi E	2 Bridge: 1.3-Mi W, .7-Mi E	3 Bridge: Ea 3000-ft	1 Bridge: 2 Miles	1 Bridge: 3 Miles	4-Mile Central	4-mile East	10.7-Mile Causeway
Upper Section	15,632	36,908	28,754	28,173	29,758	36,791	42,891	37,882	68,738
Upper Section Averaged	1,202	2,839	2,212	2,167	2,289	2,830	3,299	2,914	5,288
Lower Section	123,760	280,855	219,700	220,871	221,459	276,573	323,123	281,983	511,233
Lower Section Averaged	11,251	25,532	19,973	20,079	20,133	25,143	29,375	25,635	46,476
Upper and Lower Section Total	12,453	28,371	22,185	22,246	22,422	27,973	32,674	28,549	51,763

TABLE 4b: CALCULATION OF COSTS USED IN COST EFFECTIVENESS ANALYSIS (\$1000)

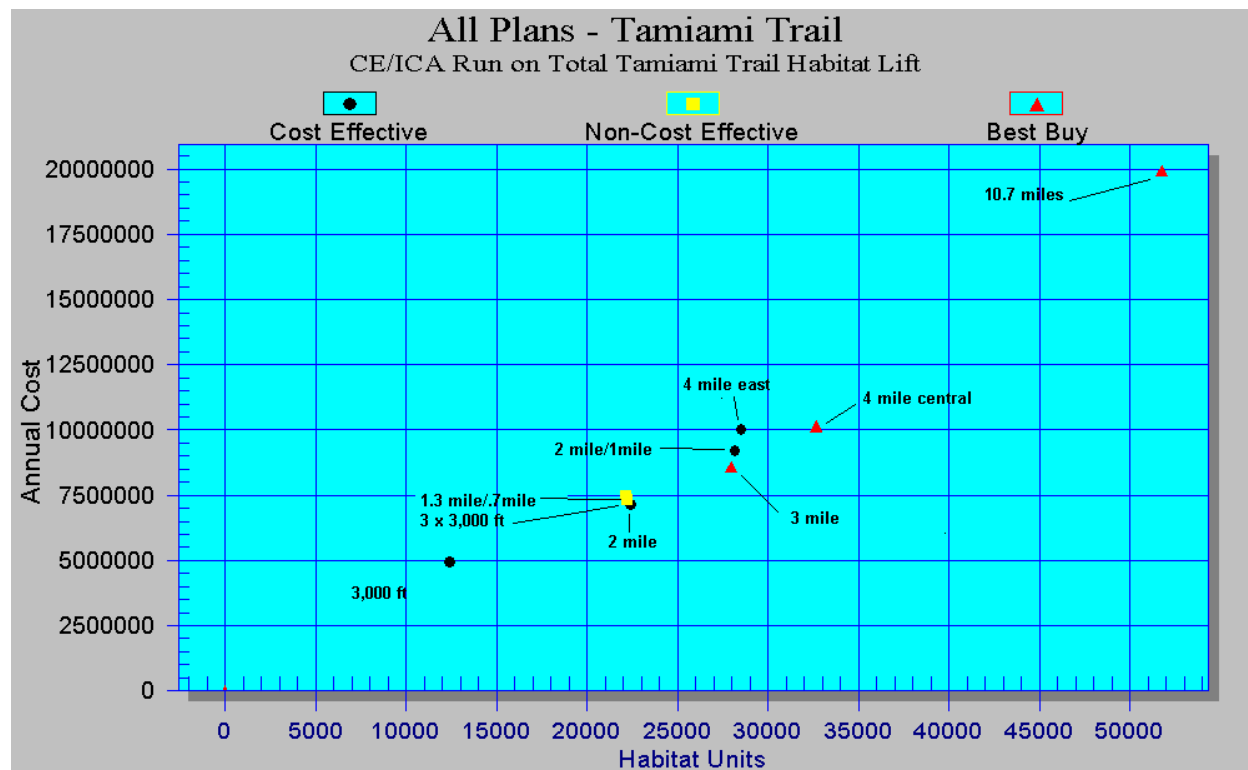
	3,000ft	2 Mile / 1Mile	1.3 Mile / .7 mile	3 X 3,000ft	2 Mile	3 mile	4 Mile Cent	4 Mile East	10.7 Miles
Construction Cost	\$68,300,000	\$127,900,000	\$104,100,000	\$101,800,000	\$99,300,000	\$119,500,000	\$141,400,000	\$139,200,000	\$278,000,000
PED & EDC (6%)	\$4,098,000	\$7,674,000	\$6,246,000	\$6,108,000	\$5,958,000	\$7,170,000	\$8,484,000	\$8,352,000	\$16,680,000
S/A (8%)	\$5,464,000	\$10,232,000	\$8,328,000	\$8,144,000	\$7,944,000	\$9,560,000	\$11,312,000	\$11,136,000	\$22,240,000
Total Construction	\$77,862,000	\$145,806,000	\$118,674,000	\$116,052,000	\$113,202,000	\$136,230,000	\$161,196,000	\$158,688,000	\$316,920,000
Construction Schedule	36 Months	36 Months	36 Months	36 Months	36 Months	36 Months	36 Months	36 Months	36 Months
Real Estate	\$114,000	\$114,000	\$114,000	\$114,000	\$114,000	\$114,000	\$114,000	\$114,000	\$114,000
	39 Months	39 Months	39 Months	39 Months	39 Months	39 Months	39 Months	39 Months	39 Months
Total	\$77,976,000	\$145,920,000	\$118,788,000	\$116,166,000	\$113,316,000	\$136,344,000	\$161,310,000	\$158,802,000	\$317,034,000
IDC Construction	\$6,447,771	\$12,074,231	\$9,827,423	\$9,610,295	\$9,374,286	\$11,281,240	\$13,348,681	\$13,140,993	\$26,244,224
IDC Real Estate	\$21,146	\$21,146	\$21,146	\$21,146	\$21,146	\$21,146	\$21,146	\$21,146	\$21,146
TOTAL INVESTMENT	\$84,444,917	\$158,015,377	\$128,636,569	\$125,797,440	\$122,711,431	\$147,646,386	\$174,679,826	\$171,964,138	\$343,299,369
O&M	\$16,522	\$18,602	\$17,747	\$17,494	\$17,747	\$18,602	\$19,457	\$19,457	\$25,188
Period of Analysis	50	50	50	50	50	50	50	50	50
Annualization	\$4,896,168	\$9,161,829	\$7,458,427	\$7,293,813	\$7,114,884	\$8,560,628	\$10,128,044	\$9,970,586	\$19,904,708
Total Annualized Cost	\$4,912,690	\$9,180,431	\$7,476,174	\$7,311,307	\$7,132,631	\$8,579,230	\$10,147,501	\$9,990,044	\$19,929,896

Cost Effectiveness and Incremental Cost Analysis

Cost effectiveness and incremental cost analyses were conducted for each of the Tamiami Trail alternative plans. The analyses compared the alternative plans' average annual costs against the appropriate average annual habitat unit estimates. The average annual outputs were calculated as the difference between with-plan and without-plan conditions over the period of analysis (through year 2060). Costs used for CE/ICA are displayed in **Table 4b**. Outputs used for CE/ICA are displayed in **Table 4**. The basis for average annual output calculations was previously explained. Note that the output values shown reflect the differences between without project and with project on an average annual basis (i.e., ecological "lift" provided by each of the alternatives).

The following table and figures represent the results of cost effectiveness analysis for the nine Tamiami Trail alternatives. **Figure 1** shows costs and outputs for all alternative plans. **Table 5** shows that the only two plans that are not cost effective are the 1.3 mile / .7 mile bridge combination and the three 3,000 ft bridges. **Figure 1** shows the cost effective and non cost effective plans.

FIGURE 1: TAMIAMI TRAIL ALTERNATIVE PLANS – CE/ICA RUN ON COMBINED AVERAGE ANNUAL HABITAT UNITS FOR ALL ALTERNATIVES



**TABLE 5: RESULTS OF COST EFFECTIVENESS ANALYSIS
(ALL ALTERNATIVE PLANS)**

Alternative	Average Annual Cost	Average Annual Habitat Units	Average Annual Cost Per Average Annual Habitat Unit	Cost Effective
3,000ft	\$4,912,690	12453	\$394	YES
2 Mile / 1Mile	\$9,180,431	28371	\$324	YES
1.3 Mile / .7 mile	\$7,476,174	22185	\$337	NO
3 X 3,000ft	\$7,311,307	22246	\$329	NO
2 Mile	\$7,132,631	22422	\$318	YES
3 mile	\$8,579,230	27973	\$307	YES
4 Mile	\$10,147,501	32674	\$311	YES
(4 Mile East)	\$9,990,044	28549	\$350	YES
10.7 Miles	\$19,929,896	51763	\$385	YES

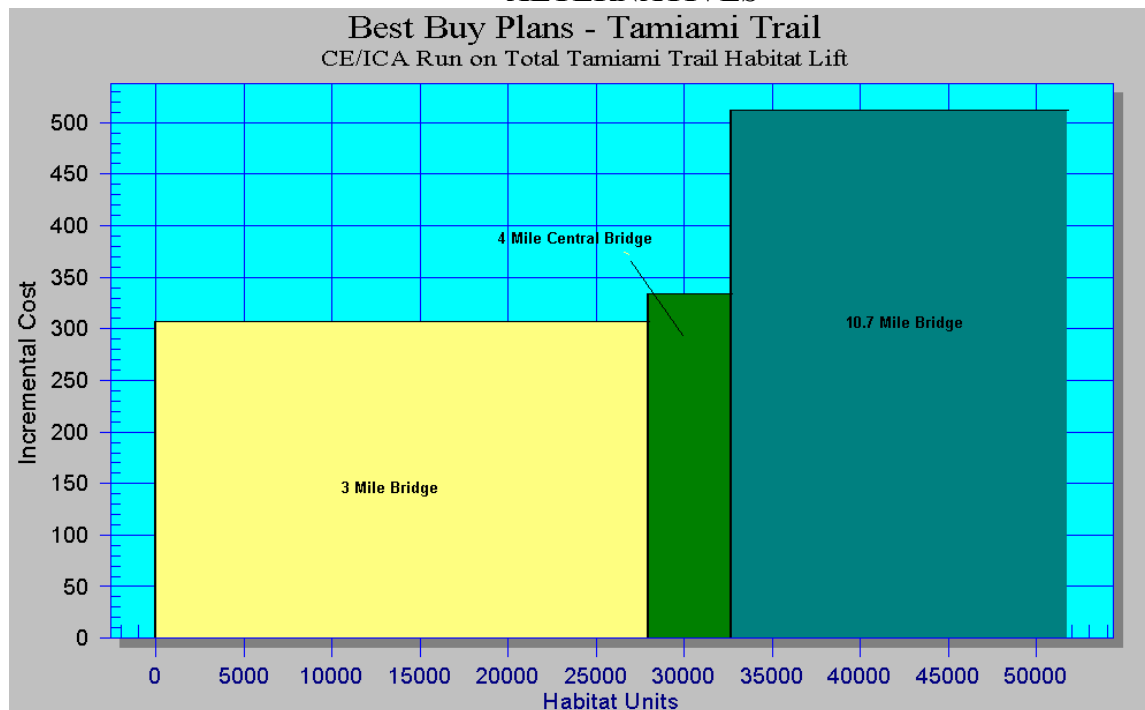
Next, incremental cost analysis was performed on these cost effective plans. *Table 6* shows the result of this. The first Best Buy plan, the three mile bridge, exhibits an incremental cost of \$307 per habitat unit, delivering a total of 27,973 average annual habitat units. The second Best Buy plan, the four mile central bridge, delivers an additional 4,701 average annual habitat units at an incremental cost of \$333 per habitat unit. The final Best Buy plan, the 10.7 mile bridge, provides an additional 19,089 average annual habitat units and an incremental cost of \$512 per habitat unit. These results are displayed in *Figure 2*.

**TABLE 6: RESULTS OF INCREMENTAL COST ANALYSIS: COST EFFECTIVE &
BEST BUY PLANS ARRAYED BY INCREASING OUTPUT FOR COMBINED
HABITAT (ALL PLANS)**

	Average Annual Cost	Output	Average Cost Per Output	Incremental Average Annual Cost	Incremental Output	Incremental Cost Per Output	Best Buy?
Without Plan	\$0	0	N/A	N/A	N/A	N/A	

3 Mile Bridge	\$8,579,230	27,973	\$307	\$8,579,230	27,973	\$307	Best Buy
4 Mile Central Bridge	\$10,147,501	32,674	\$311	\$1,568,271	4,701	\$333	Best Buy
10.7 Mile Bridge	\$19,929,896	51,763	\$385	\$9,782,395	19,089	\$512	Best Buy

FIGURE 2: TAMIA MI TRAIL BEST BUY PLANS – CE/ICA RUN ON ALL ALTERNATIVES



The single three mile bridge alternative is depicted as a best buy plan, while the 2 mile –1mile alternative is only considered cost effective, because the multiple bridge spans require more inclines and declines increasing the total cost by a great percentage than the benefits. There are public perception, acceptability, and uncertainty issues associated with the single span alternatives, however. CE/ICA is only one tool in selecting the National Ecosystem Restoration Plan and many criteria can influence the decision making process.

Identification of the National Ecosystem Restoration (NER) Plan

(Use Decision making matrix here.....)